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MOCK-UP AS A TOOL FOR KNOWLEDGE TRANFER IN OUT-SOURCING

Master of Science Thesis

Examiner: university lecturer Jouni Lyly-yrjänäinen and associate professor Teemu laine.
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ABSTRACT

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Outsourcing is one of the key strategies that allows management to focus on core capabilities of a company. Thus, it helps companies to gain sustainable competitive advantage. However, outsourcing can bring much more benefits than that. On the other side, companies tend to fail in achieving these benefits because of many different reasons. Common problem that companies face during outsourcing is knowledge transferring process. Inter-organizational knowledge transfer is complex process which requests a lot of commitment and collaboration from both companies.

The objective of this thesis is to introduce mock-up as a tool for inter-organizational knowledge transfer, and to explain how it can improve communication between two companies and knowledge creation process. During knowledge transfer the knowledge flow usually goes in one direction from a donor firm to a recipient and it is difficult to communicate ideas in other direction. However, mock-ups can help to overcome this problem.

This study shows that a mock-up was an effective tool that help companies to improve their inter-organizational knowledge transfer during outsourcing process. In addition, it showed how mock-up helped in supporting ideas and claims.

PREFACE

During my master studies I was looking to have a chance to work in a company and to try myself in real business project. I found a place in the case company. I have had a wonderful time working on this and other projects there and I am looking forward to continuing my journey there.

I want to thank the stuff of the case company for giving me such an amazing opportunity to work on that project and helping me throughout all the stage. During my two years in the case company I have learn a lot and gained incredibly valuable experience. I am happy about the outcomes of the project and excited about its future.

I would like also to thank people from the OEM which most certainly played crucial role in the project, and it would not be possible without their commitment. Moreover, I want to thank Dr. Lyly-yrjänäinen for guiding and mentoring me throughout whole my study period in Finland and helping me with writing my thesis. Finally, I would like to thank my family because they made it possible for me to study here.

Tampere, May 2018

Artur Nikitin

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1. INTRODUCTION

1.1 Background

In today's business world companies aim to outperform each other using different approaches and strategies. During the past decades researchers have been investigating the question "why some companies outperform others?". Among other theories one belongs to Barney (2007). He claims that some companies have better capabilities than their competitors. This factor allows these companies to outperform their competitors. Lysons (2006) distinguishes this outperformance as competitive advantage. Thus, it is possible to say that the main goal of firms is to focus and obtain competitive advantage. For instance, Johnson (2014) claims that strategic or core capabilities help companies to get the competitive advantage. Hence, companies must focus on their core capabilities in which they are better than other companies. There are many solutions and strategies which allow companies to do that. Fawcett (2014) claims that outsourcing is one of them. Lysons (2006) says that outsourcing is a sourcing strategy. The idea of this strategy is to switch from doing some activities in-house and find an external provider for these activities. Hence, the outsourcer has more opportunities to focus on core capabilities. Thus, outsourcing is considered an important tool that helps companies to obtain competitive advantage.

Even though outsourcing has been a common practice for years, companies still sometimes struggle to reach positive effects of it (Lysons, 2006). This happens because of different reasons. A common problem is knowledge transfer from one company to another (Hawk et al., 2009). The knowledge transfer process from the client company to the provider company is called inter-organizational knowledge transfer (Easterby-Smith et al., 2008). However, the concept has not been studied much. Most of the literature regarding this topic is focused on intra-organizational knowledge transfer which means transfer within one organization. On the other hand, the existed literature says that the knowledge transfer is a complex process (Easterby-Smith et al., 2008; Wijk et al., 2008; Martikenaite, 2011). It needs to be done carefully and requests a lot of involvement from both companies: a donor and a recipient. There have been different studies which highlight variety of companies' antecedents. These antecedents may have impact on the knowledge transferring process. However, there has been a little discussion about how to overcome problems during this process. One of the biggest problems regarding the knowledge transferring process is knowledge transfer between two companies.

In this thesis, fully functional mock-ups are suggested as a tool for knowledge transferring process. A fully functional mock-up is a recently introduced concept (Pour, 2015). It is a type of prototypes. Traditionally prototypes have been used in product development and

process development. The use of mock-ups and prototypes has grown significantly. Prototypes and mock-ups serve variety of purposes depending on their complexity. However, fully functional mock-ups have some important benefits comparing to common prototypes that makes it more suitable for knowledge transferring purposes.

1.2 Objective

This thesis introduces fully functional mock-ups as a tool for knowledge tranferring process. Fully functional mock-ups have benefits of both low- and high-fidelity prototypes (Preece et al., 2002). Thus, with almost the same functionality as late stages prototypes, fully functional mock-ups can bring comparable value with much less costs. It makes fully functional mock-up a usefull tool for the knoweldge transfer, especially in context of outsourcing.

In this thesis outsourcing is divided into different categories, some of them need parts of product development process. Prototypes have been used frequently in product and process development. However, most of the protyptyes are either too expensive or too simple. On the other hand, fully functional mock-ups can fulfill more purposes than simple prototypes at the same time they can have same functionality as expensive prototypes. The nature of fully functional mock-up allows it to be used in the knoweldge tranferring process and bring many benefits with small costs. Thus, the objective of the thesis is...

> *... to introduce mock-up as a tool for inter-organizational knowledge transfer in outsourcing process.*

To address this objective, this thesis reviews the literature concerning outsourcing, knowledge transferring and prototyping. Next, a framework is designed to emphasize the importance of knowledge transfer during outsourcing and to demonstrate the ability of fully functional mock-ups to improve knowledge transferring process. Finally, this framework is tested in an outsourcing project in the case company.

1.3 Research Process

The research process unofficially started in March of 2016, when the author of this thesis started working on the outsourcing project in the case company. The aim of the project was to outsource bundle making process from the OEM to the case company, which is a hose assembly production facility. The author joined the outsourcing team after some actions had already happened and the project had been ongoing for a year and a half. It was a long process, and it is still ongoing. However, it has already showed some surprising results.

In the beginning it was OEM's sourcing manager's idea to outsource a part of their process to the case company. However, the problem was that this process had never been outsourced by any other company. Thus, there was a need for innovations. Hence, it took

a long time from the first idea to the first results. The OEM's managers wanted to outsource bundle making process to Supplier Oy. Traditionally, bundles were made in the OEM and suppliers only delivered hoses for the bundles. However, OEM's managers always wanted to change that. Hence, close collaboration between the OEM and Supplier Oy had resulted in the innovative way of making these hose assembly bundles by Supplier Oy.

The project started in September 2014 and it took one and a half year from the project team to outsource the first bundle. There were several reasons why the project was going that slow. First, even though OEM's sourcing managers were interested in this project engineers and production managers were sceptic about the it. Hence, they were not fully committed to the project. However, their participation and help were crucial for the case company. Second, since no one has ever outsourced this activity there were many problematic moments. Solving these problems took significant amount of time. Third, it was decided to keep project lean. Hence, there were extremely small investment in the project. The author joined the case company and the project team when the first bundle was outsourced. After that project started to move faster, mainly because more people started believing in the project. Figure 1 shows the milestones of the project after the author joined the team.

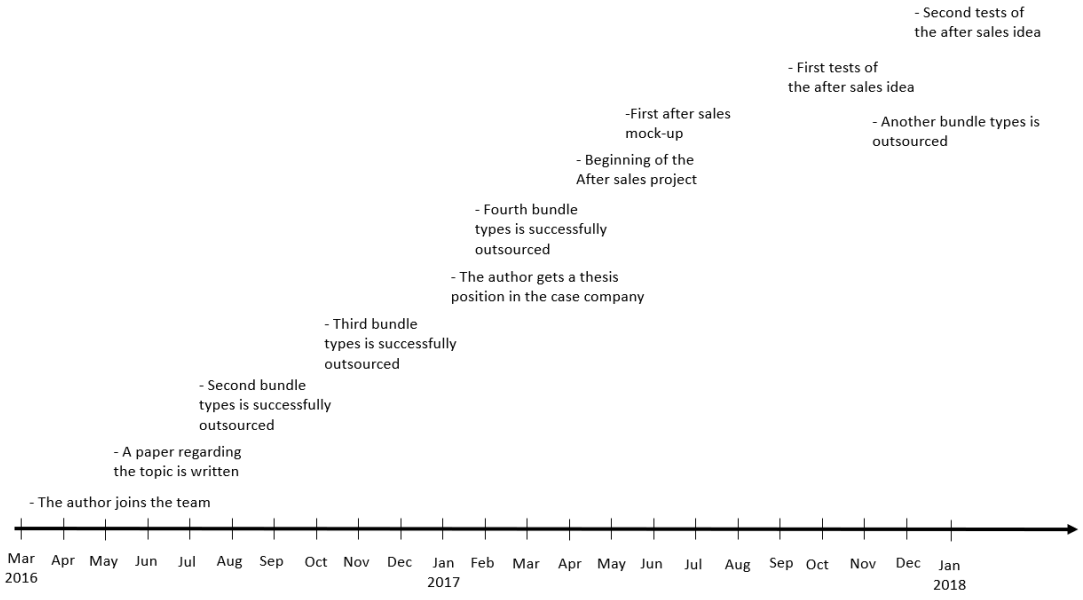

Figure 1. *Milestones of the project.*

Figure above shows main moments of the project. During the outsourcing process there were many problems and the process was not easy. Thereby, it was going quite slow. During this time the project team has achieved many important goals such as outsourcing several different bundle types. Figure 2 represents more detailed schedule for an outsourcing process of the last outsourced bundle.

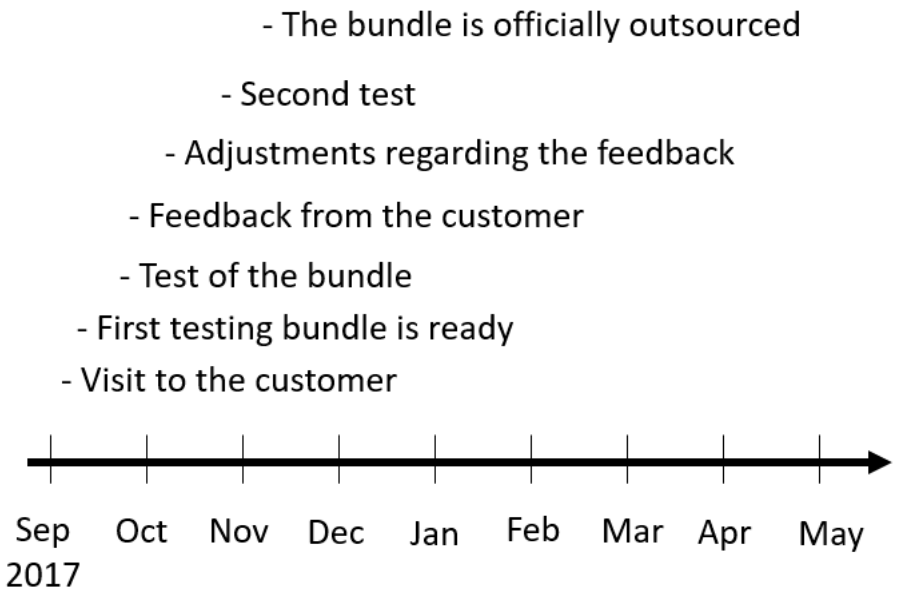

Figure 2. *A typical outsourcing process of a bundle.*

Figure 2 shows that the last bundle was outsourced in less than two months. Moreover, it could have been much faster since it takes only one or two days from the customer visit to the first testing bundles. However, it takes some time to test the bundle and then get the feedback. Moreover, it takes a lot of time because to outsource a bundle the project team from the case company has to get access to a machine. However, the production is rather booked, and it is difficult to find a window to allow the project team to work with the machine. Moreover, since the OEM has many different machines with various options there is some time between two identical machines are in production depending on the machine it could be from a week to several months.

1.4 Data Gathering Methods

According to Amaratunga et al. (2002), research is a process of enquiry and investigation. This process is systematic and methodical and aims to increase knowledge. Moreover, research could be empirical or theoretical. The desire of the researcher drives him to apply one of these methods. Theoretical research implies work with existing literature and theories to answer the research question or create a new framework. On the contrary, with empirical study a new framework is commonly supported by real life investigations. Simon et al. (1996) claim that traditionally empirical study consists of following steps:

- Statement of a problem
- Review of the literature
- Construction of a framework
- Collecting data through different methods
- Conclusion based on analysis of gathered data

Furthermore, research can be divided to qualitative and quantitative (Amaratunga et al., 2002). Quantitative research approach comes from the academic world and focuses on numbers that represent opinions and concepts. In contrast, the qualitative approach is based on observations and describes people in nature situations. However, most of research methods are combinations of quantitative and qualitative approaches (Voss et al., 2002). Simon et al. (1996) agree that the use of both approaches together gives a clearer picture on the problem.

Empirical study is divided into four types: experiment, case study, survey and postmortem analysis (Wohlin et al., 2006). This thesis is a case study. Hence, some characteristics and features of this approach should be discussed.

Case study has become widely accepted as a tool in management research. Case study research includes both qualitative and quantitative methods. Although qualitative approach normally prevails, they should both be used where they are more appropriate. (Gummesson, 2000)

The case study could be defined as study of a single unit in order to deeply understand a larger class of similar units (Gerring, 2004). However, to study and analyze the case, data should be gathered. Gummesson (2000) suggests five different methods how to gather data using different approaches. Table 1 presents these methods with brief explanation.

Table 1. *Data gathering methods (Gummesson, 2000).*

Method	Description
Existing materials	In this method the focus in on the existing materials (books, articles, journals etc.) other than humans. It is often referred as a secondary source.
Questionnaire survey	This type of questionnaire is normally formalized and done with prepared set of questions. It is typically done by phone or email.
Questionnaire interviews	On the opposite this questionnaire is more informal. The main goal is to find out about different people's perceptions on the topic.
Observation	In this method a researcher observes an object of the study to gather information.
Action science	In this method a researcher totally involved in the process. It also may contain any of the other methods.

The goal of this study to create a theoretical framework regarding the importance of knowledge transfer during the outsourcing and possible impact that usage of fully functional mock-ups can bring for this process. This framework was tested in a real-life outsourcing process that was going on in the case company. During the research process, various data gathering methods were used including existing materials, questionnaire interviews, observation and action research (Figure 4). To create the theoretical framework, existing literature regarding outsourcing, knowledge transfer and prototyping was studied. Moreover, during the research process, the author has visited the OEM which was outcounting parts of its business to the case company, multiple times. During these visits observation and questionnaire interviews were used. Furthermore, the author worked on knowledge transfer and took part in all development activities in the case company such as creation of mock-ups. Hence, the action science method was used as well. Figure 3 shows when different methods were used in the project.

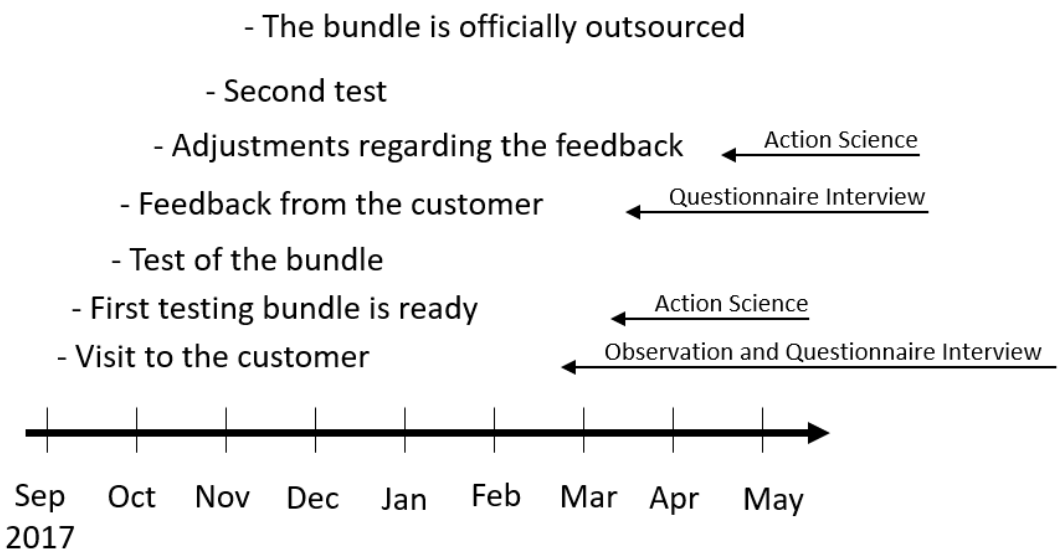

Figure 3. *Data gathering methods used in the outsourcing process.*

Figure above shows what data gathering methods were used for the outsourcing of a bundle. Even though action science includes other methods, observation and questionnaire interview were separated to highlight the importance of these methods.

1.5 Structure of the Thesis

This thesis is divided into eight chapters. Below the content and objectives of the chapters are listed:

1. Chapter 1 briefly introduces background of the main topics. Moreover, the objective of the thesis is set there. It also explains the research process and data gathering method. Furthermore, it shows which methods were used during the process.

2. Chapter 2 discusses outsourcing concept. It explains basic benefits and problems of outsourcing. Moreover, it shows new categorization of outsourcing types and discusses benefits, risks and problems of each type.

3. Chapter 3 introduces knowledge transferring process. Staging with discussion regarding knowledge creation process then intra- and inter-organizational knowledge transfer. The new framework is shown which represents the inter-organizational knowledge transfer. Moreover, antecedents of the process are discussed.

4. Chapter 4 presents current literature review on prototyping and mock-ups. It briefly describes production development process. Different types of prototypes, their benefits and purposes are discussed. Moreover, fully functional mock-ups introduced as a tool for knowledge transfer during the outsourcing process.

5. Chapter 5 briefly describes the case company and the hose assembly manufacturing process. It explains background and premises of the pre-spiraled bundle solution. Moreover, the beginning of the case company project is showed there.

6. Chapter 6 shows how the case company projects correlates with the framework form the chapter 4. The functionality and benefits of mock-up during the knowledge transferring process are highlighted and discussed. Moreover, it summarizes the outcomes findings of the research and points out limitations.

7. Chapter 7 concludes the report.

2. OUTSOURCING

2.1 Core competence and outsourcing

Nowadays, companies try to outperform each other using different approaches and strategies. Researchers have been cracking this question "how some firms outperform others?" for the past decades. According to Barney (2007), there are two different theories regarding this question. The first one originally belongs to Porter (1979, 1981). He claims that, if a firm has an ability to raise prices above a competitive level, then these performance differences can persist. Thus, Porter's idea is based on market power of a firm. On the other hand, the second explanation of why some companies outperform others is based on capabilities of a firm, its efficiency, and ability to respond to customer needs, rather than industry structure and market power (Barney, 2007). These two theories have valuable ideas on how to outperform competitors. However, according to Barney (2007), even though understanding a market power is important, this theory works better in an oligopoly environment. On the opposite, in a high competitive market second theory seems to be more appropriate since firms can sustain their superior performance through their own resources and capabilities.

Thus, it is evident that the main goal of companies is to outperform each other. Lysons (2006) names this outperformance as a competitive advantage and gives it a definition that, if a company is able to deal with market and environmental forces better than competitors, then it means that the company has a competitive advantage. In other words, if the company can create more economic value than its competitors in the same market, it has a competitive advantage (Barney, 2007). Moreover, a competitive advantage becomes sustainable when it is difficult to copy for competitors. Hence, a competitive advantage for a company means that it works more efficiently than its competitors, and this is undoubtedly what companies are seeking to achieve. Johnson (2014) explains that strategic capabilities help a company to achieve a competitive advantage. He divides strategic capabilities into two categories: resources and competences. Different authors use different terms. For instance, Hamel and Parhalad (1990), instead of competences, use term intangible assets. However, this term is too broad and includes not only capabilities, but also intangible resources such as brands. On the other hand, company's capabilities such as employees, managers, and their experience are indeed parts of intangible assets.

Thus, a company can gain a competitive advantage through its resources and capabilities. Capabilities, which lead to a company's competitive advantage, are called distinctive capabilities (Johnson, 2014). Even though Barney (2007) names it distinctive competences, the idea is the same that it is an attribute of a firm, which allows it to perform more effectively than its competitors. According to Jonhson (2014), distinctive capabilities give

to a company a sustainable competitive advantage when it is hard to imitate these capabilities. It could be a technology, employees' knowledge or a brand name. Hamel and Prahalad (1990) argue that usually a core competence remains unique because knowledge and technologies are bundled together, thus it makes copying or obtaining it by competitors even more difficult.

Thereby, a core capability or a core competence is the main aspect for a company to gain a sustainable competitive advantage. However, Teece (1987) claims that, in order to keep a competitive advantage, company's capabilities have to be dynamic. Hence, it allows the company to always be further of its competitors and keep leadership in terms of technologies or employees' experience. Thus, it is evident that duty of managers is to sustain company's competitive advantage through improving its core capabilities or developing new ones. Basically, it can be said that a company should focus only on their core activities in which they have a competitive advantage. However, in the modern world firms usually do much more than that. Hence, managers are stuck with solving problems which are not company's core competences. Fawcett (2014) claims that, once a company figures out what its core competences, it can design its supply chain in a better way. Moreover, it almost always involves outsourcing.

First, it is important to define what outsourcing is. According to Lysons (2006), outsourcing could be defined as a sourcing strategy when non-core business activities, which used to be done in-house, are transferred to specialist external providers.

Fawcett (2014) adds that outsourcing is a process of transferring an activity of production, service, or business function which was originally done within an organization to an outside supplier. Companies may outsource activities where they feel that they have lack of competence, or they do not want to perform them in-house anymore by other reasons. Moreover, the major focus of outsourcing has moved from peripheral activities such as catering, cleaning and security to more critical areas of the business such as designing, manufacturing, marketing and IT (Marshall et al, 2007).

Furthermore, Fawcett (2014) argues that outsourcing process does not end after activities have been transferred. Management of outsourcing supplier is a part of outsourcing process. Thus, outsourcing is defined as a complex process of transferring non-core activities, which were originally done in-house to an outside supplier and further development of cooperation.

2.2 Benefits of outsourcing

As claimed, focusing on core capabilities of a company should be the main job of managers. Lysons (2006) claims that the main benefit of outsourcing among others is that it frees management time. He says that outsourcing helps a company to focus on its core business activities (core capabilities). Thus, outsourcing should be considered by each

company. Christopher (2005) agrees that the tendency for outsourcing is based on a fact that companies have more chances to succeed if they focus on the area where they have an advantage over competitors.

However, Lysons (2006) adds that there are other benefits that could be reached through outsourcing. Figure 4 shows additional benefits of outsourcing and how often they are achieved by companies.

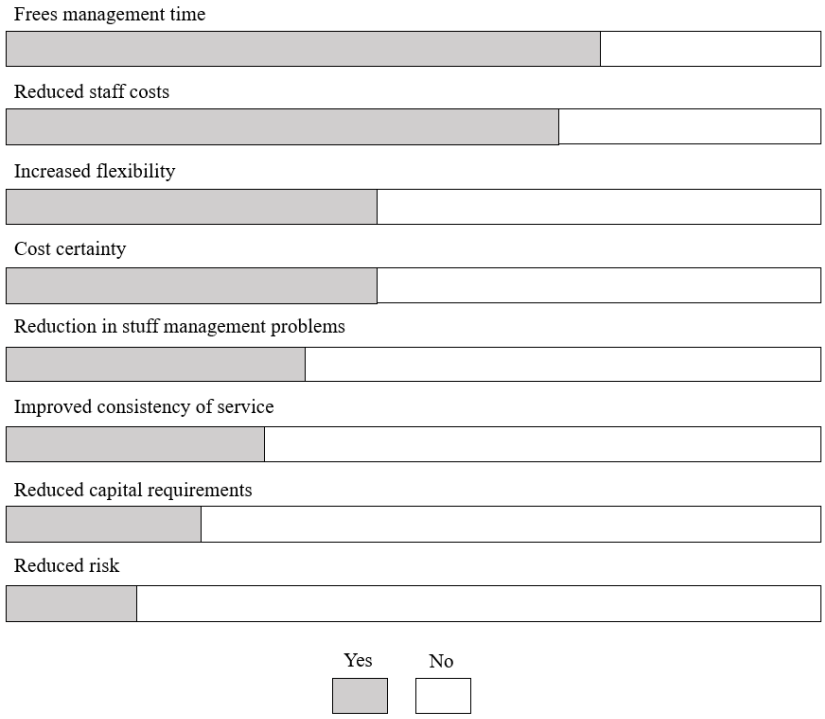

Figure 4. *Main benefits of outsourcing (Lysons, 2006).*

First, outsourcing provides more free time for managers to focus on core competences of a company. Because they no longer have to waste they time on activities that easily could be done by outsiders. Second, reduction in stuff costs comes from a case that some employees are no longer needed since their job has been outsourced. This is a common situation for outsourcing. Thus, most of the companies achieve this benefit. However, Fawcett (2014) argues that it is important to understand that outsourced activity still will be required of management.

Third, suppliers are usually more flexible since, for them outsourced activity usually is a part of their core capabilities, they can offer bigger spectrum of services and productivity, and experience. This is a valuable benefit for companies with seasonal demand.

Cost certainty refers to a fact that most of the costs are written in the contract between two parties. Moreover, an outsourcing firm gets rid of unexpected wastes and risks.

The next benefit is related to other benefits. Because outsourcing usually means reduction in the number of employees, it also might reduce costs related to management. However, Figure 1 shows that less than 40 per cent of companies have reached that benefit.

Moreover, outsourcing sometimes improves consistency of service. It happens since often a company which provides these services is specialized on them. Hence, it is a core activity for that company, which means that it is done on a good level.

Next, when a company needs a greater capacity, instead of investing money in equipment the company outsources production of extra products to a supplier. Thus, the company avoids investments, and reduces capital requirements, one of the most common benefits regarding manufacturing outsourcing.

When a company outsources something to a supplier they share risks. Thus, in a sense, there is risk reduction. On the other hand, outsourcing brings many risks as well.

However, many companies are not able to achieve all the benefits they want from the outsourcing process. This happens because of different reasons. First, some companies do not try to get all the benefits from outsourcing and they are satisfied with getting the first two benefits. On the other hand, there are different types of outsourcing which are aimed to reach different goals. For example, Quelin and Duhamel (2003) argue that the cost reduction is possible if an external supplier has an economy of scale that outsourcer does not have.

Moreover, to the benefits, discussed previously, Beulen et al. (2000) adds some drivers of outsourcing:

- Core business
- Quality
- Cost reduction
- Finance
- Cooperation

First, as said many times, a company should focus more on their core business activities. Outsourcing is an excellent tool to achieve that since all subsequent activities potentially could be outsourced. Second, supplier could provide better quality than it is possible to reach within an outsourcer company itself. Moreover, a supplier might provide lower prices for his product or service; usually this is possible since this supplier has a greater economy of scale than an outsourcer. In addition, with limited finances a company, instead of making an investment, can outsource part of the production.

Moreover, Kermic et al. (2006) in their literature review highlight benefits which have been described in literature regarding outsourcing:

- Cost savings
- Reduced capital expenditures
- Capital infusion
- Quality improvement
- Greater flexibility
- Access to latest technology
- Access to better skills
- Increase focus on core functions

Some of the benefits are the same. However, Kermic et al (2006) adds some new benefits such as access to latest technology and access to better skills. Because suppliers to whom other companies can outsource their activities usually have these activities as their core capabilities. Hence, their employees have better skills in terms of these activities and, perhaps, they have better technology since they are more interested to invest resources on it.

Based on this information it is possible to conclude that outsourcing is a useful tool which can serve different goals, depending on what a company wants to reach. Benefits which outsourcing can bring to the company are listed below. However, it does not mean that all the benefits could be reached at the same time. These benefits are gathered from different sources and represent most common ones which a company might get by outsourcing. The table below shows benefits of outsourcing.

Table 2. *Benefits of Outsourcing.*

Benefit / Author	Core Competence	Cost saving	Quality Improvement	Avoidance of investment	Cooperation	Risk Reduction	Increased Production Capacity	Access to skilled employees and new technologies
Lysons (2006)	+	+	+	+		+	+	
Kremic et al. (2006)	+	+	+	+				+
Beulen et al. (2000)	+	+	+	+	+	+		
Fawcett (2014)	+	+	+		+			+
O'Riordan et al. (2005)		+	+	+				+

Table 2 shows that most of authors agree that focus on core competences and cost saving are the most common benefits expected by companies as well as quality improvement. Other benefits are rarer. Authors agree that outsourcing is a tool for companies to meet an increased demand and, hence, avoid investments in their non-core activities. Outsourcing, as some authors say, gives flexibility to an outsourcer to get high capacity with small investments.

However, it is evident that with outsourcing it is not possible to get all of these benefits, and when companies try to get all of them, they usually fail to reach even one. Thus, it is important to understand that there are different types of outsourcing and each type can provide different benefits. Hence, it is crucial for a company to understand what benefits they can really get from outsourcing.

2.3 Classification of outsourcing

To begin with, there are plenty classifications of outsourcing. However, there is no major one. Hence, different authors suggest different approach. For example, Lysons (2006) defines three types of outsourcing:

- Body shop outsourcing
- Project management
- Total outsourcing

First type means short-term outsourcing of a simple activity in order to meet temporary high demand. Second one is about outsourcing some of projects such as IT, consultancy and training. Moreover, total outsourcing is a type of outsourcing where a supplier gets full responsibility for a selected area. This taxonomy indicates that outsourcing could be total and partial. This is important to correlate benefits from outsourcing to each category. Because with partial outsourcing the most valuable benefit is that a company can meet temporary demand without investing in equipment which will not be needed in future

with normal demand. However, with total outsourcing criteria and benefits could be different.

Another important thing regarding this taxonomy is that services and manufacturing are separated with each other in terms of outsourcing. There are traditional things which are usually outsourced such as transportation, security or cleaning. Because it is a common practice, most of the cases of outsourced services are successful and companies achieve their goals and get benefits. Although it is evident that outsourcing of services is much easier, according to Lysons (2006), the number of services that could be outsourced is almost unlimited. As a special service type, IT outsourcing could be highlighted. It is evident that there are differences between outsourcing services and manufacturing. Thus, it would be useful to divide these two into separate categories.

Another classification (Bretag, 2011) divides outsourcing into four groups. This taxonomy is rather common and accepted by different authors:

- Professional service
- Manufacturing service
- Process-specific service
- Operational service

According to this classification, professional services include accounting, information technology, purchasing and other services which require high skilled employees. The most common advantages are cost savings and high-quality services.

Second type of outsourcing is often industry specific. A typical example would be when an OEM outsource a step from the assembly to an outside company. The most common advantage is cost savings and saving in assembly time. However, the greatest problem with this type is quality of the product (Bretag, 2011).

An example for process-specific service could be a company which outsources delivery to a third-party company. This type of outsourcing is a quite popular trend since it is easy to establish (Bretag, 2011).

Operational service is common for manufacturing industry. It happens since in manufacturing industry there are many specific operations such as equipment repairs or maintenance.

Moreover, there is another classification which divides outsourcing according to the location (Andone and Pavaloaia, 2010):

- Local
- Offshoring
- Nearshoring

First, local outsourcing means that a company outsources something to a local company. Second, offshoring or offshore outsourcing refers to outsourcing from developed countries to developing such as India or China. Offshores were one of the first steps on outsourcing. The main benefit is cost reduction since wages in developing countries are lower than in developed. The last one is nearshoring. Literature usually refers this to outsourcing to nearby countries with similar or close working and business culture. An example could be outsourcing from Western Europe to Eastern Europe.

All the previously discussed types of outsourcing could be either local, offshores or nearshores. This thesis does not focus on the specific factors of offshores such as working culture. However, if a service is being offshored this has to be taken into account.

On the other hand, some activities should not be outsourced. According to Rothery and Robinson (1995), there are areas in which outsourcing is highly unrecommended:

- Management of strategic planning
- Management of finances
- Management of management consultancy
- Control of suppliers
- Quality and environmental management

It is evident that most of the core management decisions should not be outsourced, because of different risks. For instance, if a company outsources control of suppliers, it might get stuck with a supplier which is not the best in the field but has a strong relationship with a company that oversees suppliers.

Thus, by combining all the previous classifications it is possible to make a new, more accurate, one. The figure below suggests classification of different types of outsourcing.

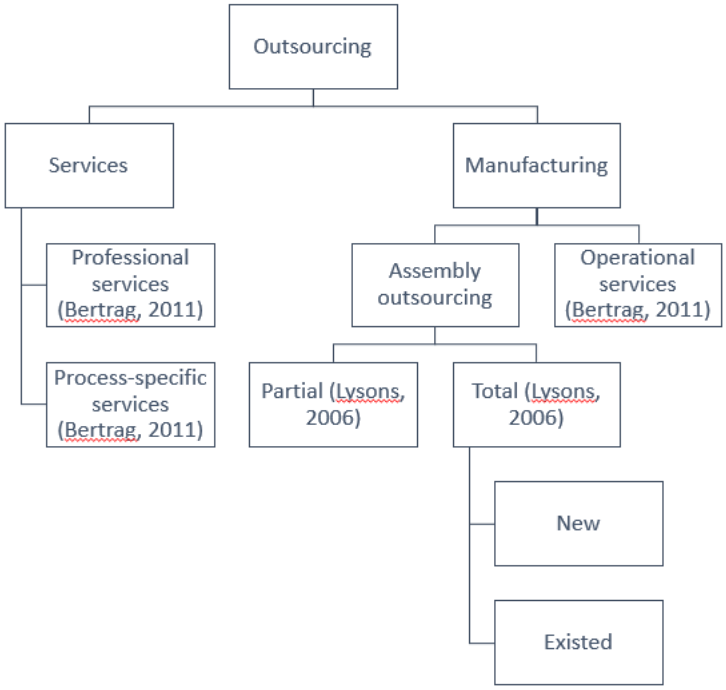

Figure 5. *Types of outsourcing.*

Figure 5 shows different types of outsourcing. The classification is needed in order to better understand what are the benefits and problems of each type. It is a mix of two taxonomies that where shown previously. Services and manufacturing are separated since the establishing process is different. Moreover, it is evident that manufacturing outsourcing is connected to industries, while services could be applied in any businesses. It is important to notice that these types could be local, offshoring or nearshoring. However, this thesis focuses on types of outsourcing regarding how it is done, but not where. Thus, the influence of different working culture will not be discussed.

Manufacturing is divided into two groups since operational services are more utility services. On the other hand, assembly outsourcing happens when a company outsources a part of the production which has been previously done in-house. It could be partial or total. The difference is that partial outsourcing serves only one reason to meet the temporary high demand, while total outsourcing is more complicated. Total outsourcing could be either new assembly outsourcing or existed assembly outsourcing. Total existed assembly means that there are many suppliers which could do these services or products. However, new assembly outsourcing means that a company outsources something that has never been outsourced yet.

Thus, after the types of outsourcing have been defined now it is possible to analyze each type regarding the benefits that a company can get through it. Figure 6 shows relation between type of outsourcing and possible benefits.

Benefit / Type	Core Competence	Cost saving	Quality Improvement	Avoidance of investment	Cooperation	Risk Reduction	Increased Production Capacity	Access to skilled employees and new technologies
Professional Service	+	+ −	+	+ −	−	−	−	−
Process-Specific Service	+	+	+ −	+ −	−	+	−	+
Operational Service	+	−	−	+ −	−	+	−	+
Partial Assemble	−	−	−	+	+	+	+	+ −
Total New Assembly	+	+	+ −	−	+	+ −	+ −	+ −
Total Existed Assembly	+	+	+ −	−	+	+ −	+ −	+ −

Figure 6. *Types of outsourcing and their benefits.*

Figure 6 shows that different types of outsourcing are aimed for different goals. Moreover, if some of the benefits are quite easy to achieve, others are difficult. For instance, all the companies expect to get some cost saving using outsourcing (Kremic et al., 2006).

Professional services, as all others, except partial assembly outsourcing, serves to free management time to allow focusing on core competence. On the other hand, cost saving are not essential and depend on agreement between companies. Because the outsourcing company are professionals, the quality is supposed to be high.

Process-specific services are quite close to professional services in terms of benefits, However, risk reduction as a benefit is added since for example, a big delivery company has more opportunities to mitigate the risks.

Operational services bring benefits in risk reduction since they are able to react fast on problems such as breaking of equipment.

Partial assembly outsourcing is needed to meet temporary demand, thus, risk reduction and increased production capacity are main benefits, as well as avoidance off unnecessary investments.

Total existed assembly outsourcing and total new assembly outsourcing provides pretty much same benefits. However, it is evident that the launching of a new outsourcing is much more difficult.

Even though there are many benefits from outsourcing, companies usually are able to reach only few of them. This happens because of multiple problems during all the steps of outsourcing process. For instance, Lysons (2006) claims that according to surveys 30 to 50 per cent of managers are disappointed with results of outsourcing. This happens due

to various problems during all stages of outsourcing process. Thus, in order to understand how to avoid these problems and mitigate these risks they should be defined.

2.4 Problems and risks of outsourcing

To begin with, there are many problems and risks related to outsourcing. First, in this thesis there will be literature review of different opinions regarding common risks and problems, then problems and risks are going to be allocated to outsourcing types, same as with benefits.

For instance, Lysons (2006) highlights following problems:

- Overdependence on suppliers
- Cost escalation
- Lack of supplier flexibility
- Lack of management skills to control suppliers
- Unrealistic expectations of outsourcing providers due to over-promising at the negotiation stage

First, if a company chooses to outsource a service to a single supplier, it would mean that, if something happens with that supplier, whole production in a firm can stop or be postponed. Thus, to avoid overdependence on a single supplier it is better to have other options as well.

Cost escalation refers to a risk when a contract is written in a way that all additional work, besides agreed one, is rather expensive. This is a risk since it is sometimes difficult to predict potential amount of work which is going to be needed from a supplier. Moreover, sometimes an outsourcer needs to make some changes in the initial agreement, yet their supplier is not able to do this, due to lack of flexibility. It is one of the key points during the outsourcing process to manage a supplier after the negotiation stage is done (Fawcett, 2014). However, if managers do not control a supplier because of have lack of experience in this, it might bring many different problems. It is difficult to predict what a supplier is capable of, if it is an unknown player. Thus, during negotiation process a supplier might take more responsibilities than he can make.

Carrington (1994) adds following problems:

- Quality of service
- Communication with suppliers
- Dependence on few suppliers
- Long-term commitment
- Reduction on flexibility

Many authors (Kremic et al., 2006; Iqbal and Dad, 2013) highlight the risk of hidden costs which come up because of poorly written contracts. Moreover, all authors agree on a fact

that poor communication between supplier and a company is often a reason for many other problems. Furthermore, Fawcett (2014) adds that there is always a risk of losing core knowledge during outsourcing process. Kremic (2006) agrees and adds that due to outsourcing a company could get a competitor.

Fawcett (2014) divides risk into two categories: strategic risks and tactical risks. Strategical risks are:

- Firm loses knowledge and/or technology to perform activity internally
- A supplier develops unique, hard-to-replicate expertise
- Suppliers activities add unique value recognized by customers
- A supplier shares knowledge with firm's competitors

Tactical risks are:

- Short-terms supply shortages
- Hidden transaction or management costs
- Loss schedule control
- Short-term price fluctuation

Thus, strategic risks are more about big picture whereas tactical are more about money and day-to-day problems. Separation these risks is a quite good approach since the mitigation of these two groups differ.

Hence, it is possible to add problems and risks highlighted by other authors and combine them with Fawcett (2014) classification. Thus, Figure 7 shows strategical and tactical risks and problems regarding outsourcing.

Strategical	Tactical
Overdependence on supplier. (Lysons, 2006; Carrington, 1994; Kremic et al., 2006)	Quality of service. (Kremic et al., 2006)
Losing core knowledge/technology to supplier. (Kremic et al., 2006; Fawcett, 2014)	Lack of supplier flexibility. (Lysons, 2006; Carrington, 1994; Kremic et al., 2006)
Losing core knowledge/technology to competitors. (Kremic et al., 2006; Fawcett, 2014)	Loss schedule control. (Fawcett, 2014)
Lack of management skills to control and communicate with supplier. (Lysons, 2006; Kremic et al., 2006; Fawcett, 2014)	Hidden transaction or management costs. (Lysons, 2006; Kremic et al., 2006; Fawcett, 2014)
Supplier adds unique value to customers (Fawcett, 2014)	Short-term price fluctuation. (Fawcett, 2014)
Long-term commitment. (Carrington, 1994)	Difficulty in meeting deadlines. (Fawcett, 2014)
Inability to transfer knowledge from in-house to suppliers. (Kremic et al., 2006)	

Figure 7. *Problems and risks of outsourcing.*

Figure 7 shows risks and problems of outsourcing gathered from different sources. It is evident that not all problems, same as benefits, are suitable for each type of outsourcing. However, there is no need to allocate each risk to each type of outsourcing since problems are similar in all services as well as in all types of manufacturing outsourcing. Thus, below there is a list of risks and problems related to outsourcing of service, both strategical and tactical:

- Quality of service
- Hidden transactional or management costs
- Lack of management skills to communicate with suppliers
- Difficulty in meeting deadlines

As it can be seen, there are not many risks with outsourcing services since this is a common practice. One of the main problem is hidden transactional or management cost. Hence, in order to overcome this Patton (1999) suggests being extremely careful making a deal with a firm. Hidden coasts usually come up when some parts of work is not fully specified and additional services might cost a lot. This problem should be overcome by good communication during negotiation process.

Another core problem, especially regarding IT services, is meeting deadlines (Brookers and Haines, 2016). This problem should be overcome during negotiation process as well. However, managing IT outsourcing is quite complicated process with its own special moments, whereas this thesis focused more on manufacturing outsourcing.

Thus, problems and risks regarding manufacturing outsourcing are shown below, first strategical ones:

- Overdependence on supplier
- Loosing core knowledge/technology to supplier
- Loosing core knowledge/technology to competitors
- Lack of management skills to control and communicate with a supplier
- Supplier adds unique value to customers
- Long-term commitment
- Inability to transfer knowledge from in-house to suppliers

Most of these problems usually occur because of poor management and decisions during whole outsourcing process and lack of experience in knowledge transferring management. For instance, when managers do not understand what the company's core knowledge is, it might be shared with outsourcing company. On the other hand, it is evident that there should be communication and knowledge sharing between two companies. Thus, it is very challenging work to share as much knowledge to the supplier as they need to perform well, but at the same time do not share core knowledge. Kremic et al. (2006) highlight an important problem that companies often fail to transfer knowledge to a supplier during the outsourcing process. The knowledge transfer is extremely important during outsourcing, especially for manufacturing outsourcing, because there is knowledge which is bound to employees. Thus, when a process is outsourced, some knowledge can be lost. Hence, a supplier might not meet expected level.

Second, tactical problems are:

- Quality of service
- Lack of supplier flexibility
- Loss schedule control

With manufacturing outsourcing the biggest concerns are quality of delivered products or services, and how good supplier follows the schedule. Moreover, there should be understanding of suppliers' capacity, if they are able to meet the fluctuating demand.

Because total new assembly outsourcing is the most challenging one, managers have to consider almost all the problems and risks. The outsourcing process will be shown step by step based on this type of manufacturing outsourcing.

2.5 Establishing of outsourcing process

Despite of impressive number of studies that have been done in this field, there are only few frameworks describing the stages of the outsourcing process. One of them is Fawcett's (2014) outsourcing process framework. Although there are some differences establishing the types of outsourcing, Fawcett (2014) claims that the outsourcing process

should include three major phases regardless whether it is manufacturing or service outsourcing. Figure 8 shows these phases.

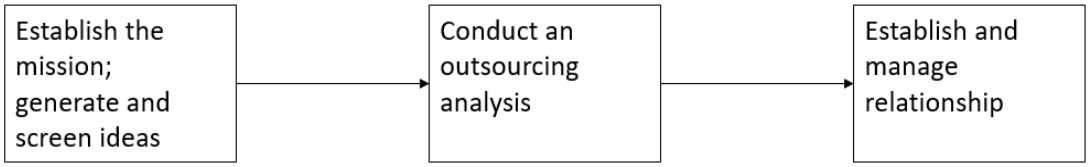

Figure 8. *Outsourcing process phases (Fawcett, 2014).*

Figure 8 shows that actual outsourcing process happens in the second phase. Two other phases are happened before and after an activity is outsourced.

In the first stage the decision of outsourcing is being made. The decision of outsourcing should be made by high-level managers. Their participation is necessary in order to avoid outsourcing of core activity (Fawcett, 2014). Figure 9 shows an example of question which should be discussed before deciding about outsourcing.

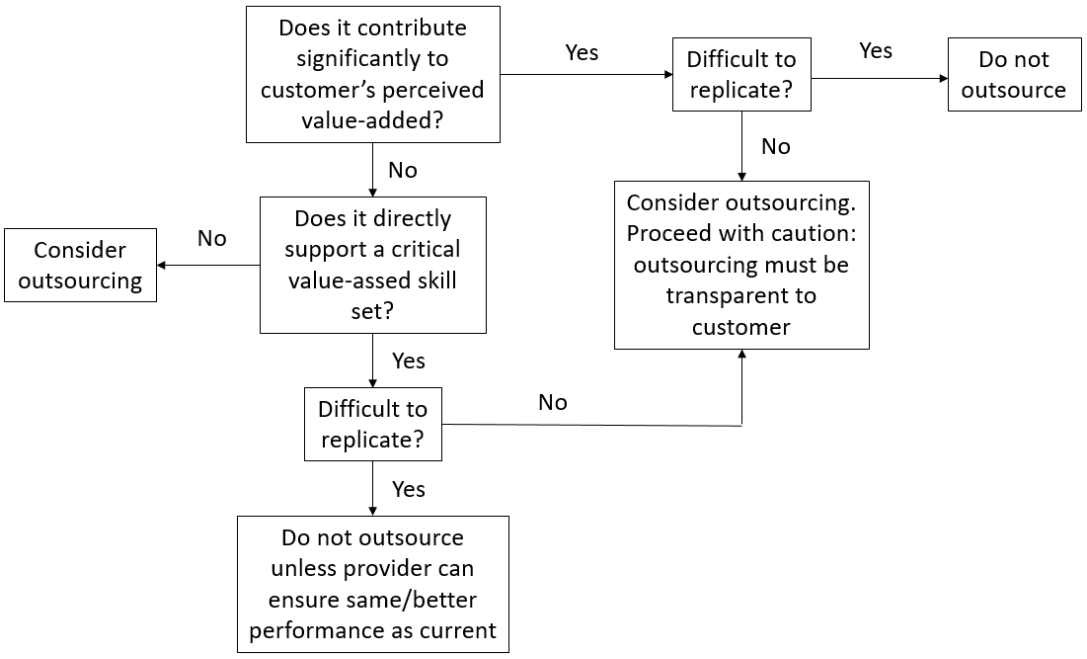

Figure 9. *Questions to consider in outsourcing activities (Fawcett, 2014).*

Figure 9 shows that there are some crucial questions which should help to understand if outsourcing could be done. Moreover, during the first phase of outsourcing process managers should decide what benefits they want to achieve (Fawcett, 2014). This is important step since some of the benefits could be reached only if some are sacrificed. For instance, if high quality is essential for a firm, then cost reduction might not be the main targeted as a benefit. Managers should have clear understanding of benefits which they could get. Furthermore, risk analysis should be conducted.

Even though Perunovic and Pedersen (2007) name stages in different way, the concept of the first phase is the same. They add that key activities of the first step of outsourcing process should include building of outsourcing strategy and making clear vision on why and what to outsource.

During the second phase, an outsourcing team should be formed including people from different key departments, which will be affected by outsourcing outcomes, such as logistic, supply and finance, including those who are involved in the day-to-day activities (Fawcett, 2014).

One of the most important parts of this stage is identifying potential suppliers. Fawcett (2014) claims that careful assessment of the suppliers should be done. Criteria for a potential supplier should be done based on the benefits which a company wants to achieve through outsourcing process.

For instance, if an OEM has decided that a part of its production should be outsourced, since that activity does not provide much value for OEM's customers and there are suppliers who can provide this service. Then the first thing that this OEM's outsourcing team should do is, as discussed, define the benefits of outsourcing that they want to achieve. For example, a company has made a big deal with a new client for the upcoming year and the demand is going to be much more than the capacity of the OEM. Hence, instead of making an investment in the assembly line some part could be outsourced. Thus, criteria for future supplier should be an ability to meet the demand, quality and on-time delivery. Hence, one of the most common benefits of outsourcing, cost reduction, is not the main criteria for the company in this case.

If there are suppliers in the market, then a formed team should evaluate suppliers in terms of criteria which has been set. Moreover, with the most suitable ones the negotiation process should start. However, it might be that there are no suppliers in the market since no one provides this service. Thus, reverse marketing could be considered (Fawcett, 2014). This is different from common request for quotation or proposal. Basically, a customer asks a supplier to do something the supplier does not do (Leenders and Blenlhorn, 1988). This is similar to the idea of new assembly outsourcing shown in the classification of outsourcing types. However, usually this type of outsourcing means that customer and supplier already have some relationship with each other. Moreover, a development of new service must mean commitment from both parties since it might be quite difficult and long-term process without significant results for some time.

Furthermore, Fawcett (2014) claims that during this phase a company should consider potential risk, first identify them and then make a mitigation plan. Because this study is more focused on manufacturing outsourcing, an example risks mitigation will be shown for this outsourcing type in Table 3.

Table 3. *Risk and mitigation plans in outsourcing.*

Risk issue	Safeguard
Quality of service	Ensure of supplier's product quality. Additional quality control
Lack of supplier flexibility	Deeper understanding of supplier capacity during negotiation process
Loss schedule control	Punishments in terms of late deliveries
Overdependence on supplier	Make a possibility to switch to another supplier
Loosing core Knowledge/technology to supplier	Share knowledges and technologies only of there is strong relationships with a supplier
Lack of management skills to control and communicate with a supplier	Allocate experienced manager to a task or include him in a steering group
Inability to transfer knowledge from in-house to supplier	Use different techniques of knowledge transferring process

Table 3 shows examples of measures that could be taken to mitigate risks. However, it is obvious that every case should be examined separately taking into account all the nuances.

Moreover, Fawcett (2014) adds that during this phase a total cost analysis should be done. After it has been identified that in the market there are some suitable suppliers who are willing to work with the outsourcer and needs have been scoped out, total cost of ownership (TCO) can help to have deeper understanding on the true cost impact of the process.

The usual approach is to determine the total costs of in-house option and out-house even though cost reduction, as mentioned, might be not the most important benefit. However, TCO is an important tool during the outsourcing process, it allows to make a clear picture regarding costs and illuminate some risks.

Analysis should include both direct and hidden costs. However, costs which stay the same disregarding outsourcing process should not be considered. However, it is not an obvious task to identify all the costs for a manager. Hence, a cross-functional team would deal better with this task. A common mistake is to eliminate salaries of all employees who

used to oversee the in-house process. It should not be forgotten that management of outsourced process still requires some managers to coordinate the information flow between companies and reporting results (Fawcett, 2014).

Sometimes it is difficult to predict how costs will change, especially when negotiation process with suppliers is still going on. Thus, Fawcett (2014) suggests using sensitivity analysis in order to take into account different scenarios. For instance, it might not be evident how many managers are needed to communicate with a supplier and how many employees could be dismissed. Thus, all these uncertainties should be estimated. Moreover, such "what-if" analysis will show more understandable results in terms of cost efficiency of outsourcing process.

Fawcett (2014) adds that for outsourcing services or business process outsourcing the approach is quite the same as for manufacturing outsourcing. However, for service outsourcing contracting and negotiation process plays more important role. Pellicelli and Meo-Colombo (2011) even separate negotiation process as a different phase of outsourcing. During negotiations with a supplier the contract should be specific about many aspects, otherwise there is a risk of overhead costs because of additional services which were not specified in the contract.

The last phase of outsourcing process according to Fawcett (2014) is establishing and managing the outsourcing relationship. After a supplier has been chosen, the work should be transferred. It is one of the key aspects during this whole process. Moreover, this is the place where most of the failures happen (Pellicelli and Meo-Colombo, 2011). Inability to transfer important knowledge, especially if it is a case about new manufacturing usually becomes the biggest problem. Pellicelli and Meo-Colombo (2011) add what activities should be involved in the process to make it efficient:

- Set a temporary working group who is going to organize the transfer of all the needed information, knowledge and perhaps equipment. Moreover, this group should control how the outsourcing process is going. It is important to understand that it might take months (Lysons, 2006)
- Involving employees whose activities might be affected by transferring
- Ensure that managers who is going to be in charge of working with supplier be involved in decision-making

Close collaboration between two companies is a key factor to success in the outsourcing process (Kremic, 2006). However, there are different types of collaborations. Fawcett (2014) says that managing outsourcing relationships is continuous process during all interaction between two companies. Figure below shows different types of collaboration among companies.

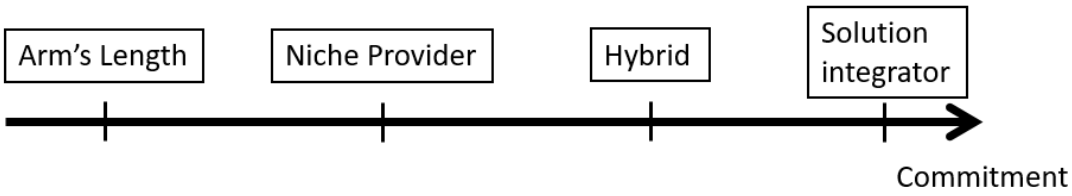

Figure 10. *The Outsourcing relationship continuum (Fawcett, 2014).*

Figure 10 shows four different categories of suppliers in terms of their commitment with customers. It is important to understand that one supplier can be in different relationships with its clients.

First, arm's length relationship is well suited for basic services or simple unskilled labor. In this type of relationships there is almost no commitment between two parties since there are many similar suppliers in the market. Furthermore, the cost of transferring work is low, and the supplier does not add value to the end product. Most of the services, besides IT, are allocated in this zone of commitment.

Second, niche providers could be quite similar to the arm's length relationship. However, the biggest difference is that they provide rather specific service. Thus, the amount of such suppliers in a market is quite low and, hence, companies are more committed to each other.

Suppliers in third category do much more for their client than just one service. Hence, they are called hybrid suppliers. They offer "turnkey" solutions and usually add value to a customer. Hybrid suppliers are integrated in customers' processes. Furthermore, sometimes boundaries between two parties start to blur and there is no clear boarder of supplier's responsibilities. Hybrid suppliers are much more difficult to substitute. It would take much more effort, time and money. Thus, usually companies try to overcome problems if there are any, although it is not impossible to replace them since the service of that supplier is not unique, it just will take time to reach this point with another supplier.

The most advanced supplier level is solution integrator. These suppliers provide full-service solutions which are deeply entrenched with the firm's own processes. This kind of collaboration takes much more time, effort and resources to achieve. These suppliers offer customized solutions for their clients, which they have developed together during their supplier-customer relationship. Changing this supplier would have high influence on the company and would mean that a firm has to insource some of the activities for a long time, until they are able to establish new relationship with another supplier to that level of commitment.

It is crucial to understand that, as all relationships, a role of supplier can change with time in both directions. Usually customer-supplier relationships start as arm's length or niche types and then with time stronger relationship develops.

In the figure below, the types of outsourcing are allocated depending on the amount of risks and relationships with suppliers.

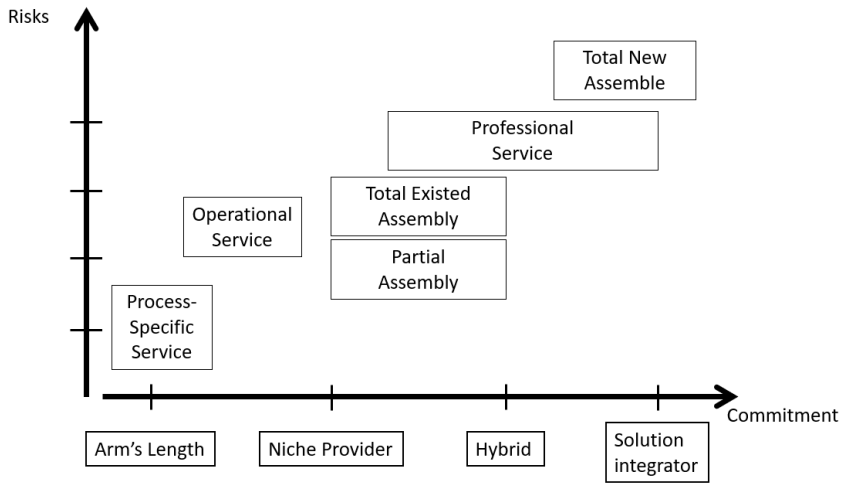

Figure 11. *Location outsourcing types regarding risks and relationships with suppliers.*

Figure 11 shows that some outsourcing processes require closer collaboration with its supplier. It is evident that some similar services could be managed within different type of relationships. However, when outsourcing process gets more complicated involvement of the parties should grow as well. Total new assembly outsourcing is the most complicated type of outsourcing (Fawcett, 2014). Moreover, the importance of close relationships in this outsourcing type is due to knowledge transferring process between two companies. According to Hawk et al. (2009), in outsourcing knowledge transfer usually means that client's employees share knowledge with the provider's company. Moreover, they claim that to succeed in the outsourcing process, the provider's employees have to absorb the knowledge that the client's employees have accrued. This statement is true for assembly outsourcing, because the client firm is usually the one that is successfully doing the process. On the other hand, a supplier might not have all required knowledge to keep product's quality or some specific features. Moreover, it is even more important for the total assembly outsourcing since a supplier does not know at all how to provide the service for the client.

Summarizing, outsourcing plays an important role for companies in the modern world. It helps companies to focus on their core competences. However, it has more benefits besides that one, although companies often fail to achieve other benefits. It discussed in this chapter why does this happens. In this thesis more attention is given to the total assembly outsourcing as the most difficult one. One of the crucial problems is knowledge transfer.

Thus, to have deeper understanding of the problem, the knowledge transferring process should be analyzed separately.

3. KNOWLEDGE TRANSFER

3.1 Knowledge and knowledge transfer

Nowadays, in the world with high competitiveness knowledge is considered as a key resource (Newell, 2005). Martinkenaite (2011) agrees that it has been widely recognized in the strategic management literature that knowledge is a strategically important resource which leads to competitive advantage. Knowledge management is highly spread in companies which are leaders in their fields. Knowledge transfer or knowledge sharing is a part of knowledge management. Because knowledge is highly valuable resource, companies are used to protect it. Hence, that makes knowledge sharing between companies a complex and difficult task. However, Easterby-Smith et al. (2008) say that, even though the ability of a company to learn from itself and others is a key to competitive advantage, knowledge transferring is quite often not that successful. There have been many studies regarding organizational learning and learning outcomes at both intra- and inter-organizational levels (Argote et al., 2003). However, often those studies are quite ambivalent. This literature review is supposed to show findings of those studies regarding inter-organizational knowledge transferring.

However, some key concepts should be defined and discussed in order to get deeper understanding on the topic. First of all, knowledge transfer should be defined. Wijk et al. (2008) define knowledge transferring process as an exchange of knowledge between different individuals, units, groups, or organizations. Argote and Ingram (2000) add that during this process one unit is affected by experience of another. In current literature knowledge transfer is mostly discussed regarding knowledge sharing within one organization. However, rare authors who has written about knowledge transferring between two companies claim that the approach is quite the same in both cases (Modi and Mabert, 2007). Organizational knowledge transfer on intra level means transferring knowledge from one person, unit, department to another (Wijk et al., 2008). It is possible to say that inter-organizational knowledge transferring has the same meaning, although it has some special features. Thereby, inter-organizational knowledge transfer is knowledge transfer between a person, unit or department from one company to a person, unit, or department in another. However, Inkpen and Tsang (2005) argue that knowledge transferring process across two different companies is more complicated than simply transferring knowledge between two departments.

However, it is crucial to differentiate knowledge, information and data. This is a key for major problems in knowledge transferring process.

First, data is raw, unprocessed facts or simply set of numbers such as 2141394 (Awad and Ghaziri, 2003). Second, information is data placed in a context or data that has meaning. For example, a telephone number of a company that begins with 214 13 94 (Awar and

Ghaziri, 2003). On the other hand, knowledge is bound to human experience and skills. Knowledge is a person's perception of information (Awar and Ghaziri, 2003).

Thus, there is a huge difference between sharing information or data and sharing knowledge. A company can simply send a data base to their supplier and the information has been transferred, whereas knowledge transferring is much more complicated process.

Moreover, knowledge can be divided by different types. Jashapara (2004) in her literature review of typologies of knowledge shows that most of the concepts divide knowledge into two categories: knowing how and knowing that. Table 4 shows what knowledge different authors identify.

Table 4. *Typologies of knowledge (Jashapara, 2004).*

	Knowing how	**Continuum**	**Knowing that**
Kogut & Znder (1992)	Know-how		Information
Nonaka (1994)	Tacit		Explicit
Blacker (1995)	Embraided	Encultured	Encoded
Spender (1998)	Individual/Implicit Social/implicit	Social knowledge	Individual/explicit Social/explicit
Cook & Brown (1999)	Knowing (tacit)	Discourse	Knowledge (explicit)
Newell et al. (2002)	Processual perspective		Structural perspective
Orlikowsky (2002)	Knowing		Knowledge

Jashapara (2004) claims that authors use different terms, but the meaning behind them is almost the same. Nowadays, the most usable concept is Nonaka's (1994) model of tacit and explicit knowledge.

Tacit knowledge is knowledge embedded in person's mind through his work, study and experience. It includes intuitions, values and believes that stem from years of experience (Awar and Ghaziri, 2003). An important feature of tacit knowledge is that it is difficult for a person to identify and measure his knowledge because it is partly subconscious (Laihonen and Jaaskelainen, 2013). Hence, transfer from one human to another is a long and difficult process.

On the contrary, explicit knowledge is knowledge written in books, documents and reports. It is physical entity and could be easily identified. Explicit knowledge is not bundled with people, so it can be easily transferred or stored somewhere, for instance in data bases. On the other hand, tacit knowledge could be kept only in a person's head. (Awar and Ghaziri, 2003)

Thus, knowledge transfer can mean both explicit and tacit knowledge. However, it is evident that usually it is tacit knowledge which creates a competitive advantage for companies. Thus, knowledge transferring is more about sharing people's experience than simply manuals. Thereby, knowledge sharing process is complicated.

Moreover, according to Hawk et al. (2009) recent research has highlighted a separate category which lies in between of explicit and tacit knowledge. It is called implicit knowledge. It represents knowledge which is not in explicit form, but it could be made explicit. In the outsourcing process implicit knowledge is usually the one that is being transferred.

Another crucial thing that should be discussed regarding the topic of knowledge transferring is Nonaka's (1994) model of knowledge conversion which includes four steps. Figure 12 represents the framework.

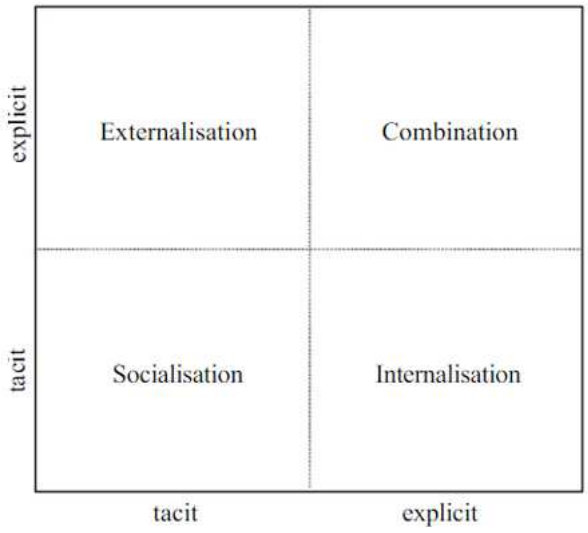

Figure 12. *Nonaka's SCEI model (Nonaka, 1994).*

1. Socialization represents transformation of knowledge from tacit to tacit by sharing experience. Tacit knowledge can be transferred from person to person in meeting and by discussions. The most common way to obtain tacit knowledge is observation and personal experience, so called master-apprentice. Sharing tacit knowledge is a long and difficult process. The reasons are that tacit knowledge is difficult to recognize, and that sometimes people do not want to share their experience.

2. Externalization process stands for transferring knowledge from tacit to explicit condition. The process consists of documenting knowledge what was shared between people. For instance, writing a report based on the discussion among employees would be an example of transferring knowledge from tacit to explicit.

3. During the combination stage knowledge transforms from explicit to explicit. Because explicit knowledge could be easily shred and modified, this type is most common one. Sending a simple email with a document would be an example of communication phase. Gathering information from different sources and combining them to one is an example as well. Technologies play big role in this process, much bigger than in others.

4. During internalization stage explicit knowledge is being transformed to tacit. For instance, when an employee uses a manual to make something, he is transferring explicit knowledge from written form to his mind. That is what makes explicit knowledge to become tacit.

An important thing that during this circle knowledge in not only being transferred from one type to another, but at the same the knowledge creation process is going on. Hence, this model is called knowledge creation process. Powell (2007) claims that this process should work as non-stop cycle. Figure 13 shows how knowledge is created according to this model.

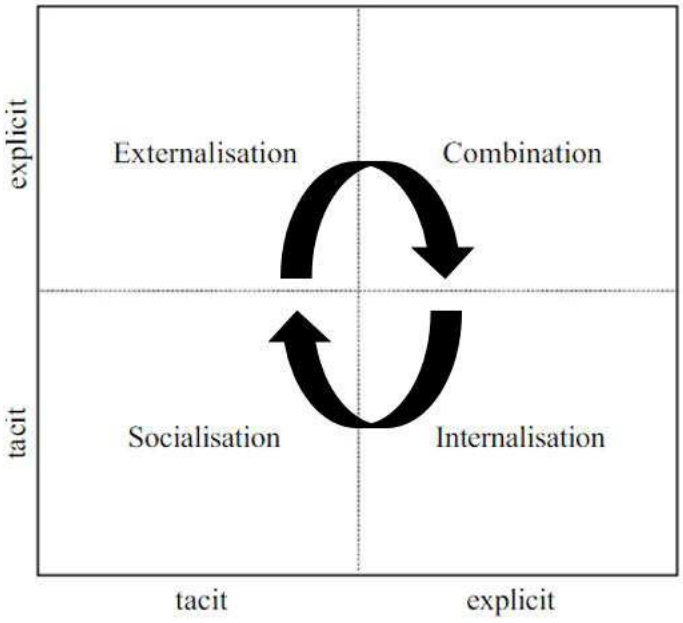

Figure 13. *Nonaka's SCEI model (Nonaka, 1994).*

Figure 13 shows that through transferring knowledge from one form to another knowledge is being created and spread within a company. Hence, each stage could be considered as a part of knowledge transfer. However, the process itself is about knowledge creation. The role of this process is to transfer knowledge from individual level to a company level. Figure 14 shows more visually how knowledge is being created in the organization.

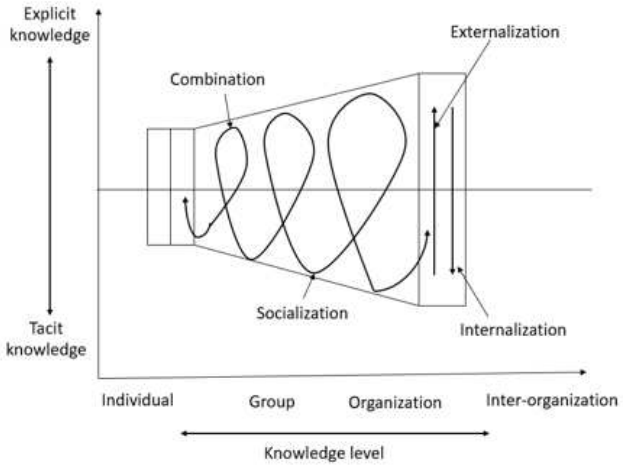

***Figure 14**. Spiral of organizational knowledge creation (Nonaka and* Takeuchi*, 1995).*

Moreover, Figure 14 shows that inter-organizational knowledge transfer happens as well in this sequence. Hence, even though Nonaka's model was created for intra-organizational knowledge transfer, it can be used to transfer knowledge to another company as well. Thus, sharing knowledge with another firm not only helps the second company to get knowledge, but together they create more knowledge, and this usually leads to innovations.

However, it would be wrong to claim that during inter-organizational knowledge transferring it is possible to separate explicit knowledge and tacit knowledge. All of it are transferred simultaneously in order to help the recipient of knowledge. Thereby, Wijk et al. (2008) add another characteristic of knowledge. They name it knowledge ambiguity. The original purpose of knowledge ambiguity is to protect company's knowledge from coping by competitors and it is considered good by the owner of the knowledge if it is complex and tacit. However, in case of knowledge transferring it is definitely a characteristic of a knowledge that makes difficult to share it. Reed and DeFilippi (1990) add that knowledge ambiguity emerges from its tacitness, specificity and complexity.

To sum up, knowledge transferring process is a complex process which leads to knowledge creation and, hence, to company's competitive advantage. Knowledge transferring, and creation process can happen both on intra- and inter-organizational level.

3.2 Inter-Organizational Knowledge Transfer

As mentioned above, inter-organizational knowledge transfer is similar for intra-organizational knowledge transfer. However, it is more complex process since companies tend to protect their knowledge from competitors. Moreover, they try to make their core knowledge difficult to copy, there are many restrictions what knowledge could be transferred and what could not. Furthermore, relationships between companies must be taken into account. Third, characteristics of both companies should be considered.

Current literature mostly focuses on antecedents and consequences of organizational learning and learning process of knowledge transfer at both intra- and inter-organizational level (Agrote et al., 2003). Antecedent of knowledge transfer is a factor which might influence the process in a positive or negative way (Martikenaite, 2011; Wijk et al., 2008). This factor can be related to knowledge, companies or relationships between firms (Wijk et al., 2008). There are quite many different opinions regarding antecedents. Researchers are arguing about their roles in the process. Martikenaite (2011) adds that, although research on that topic is burgeoning, findings are rather controversial, and understanding of inter-organizational knowledge transfer antecedents and consequences remains unclear. However, there are many similarities between different studies and most of them are working around similar framework.

First, Wijk et al. (2008) identify several antecedents of organizational knowledge transfer and divide it in three categories. They add that, although previous research had examined a scope of different antecedents, they added only those which had been studied multiple times and had been somehow proven. These categories are:

- Knowledge characteristics
- Organizational characteristics
- Network characteristics

Each group represents antecedents which are important to evaluate knowledge transferring process. First, for knowledge characteristic they highlight only knowledge ambiguity. Second, organizational characteristics include size of a company, age, decentralization and absorptive capacity. Third, network characteristics include number of relations, centralized position, tie strength, trust, shared vision, and system, and cultural distance.

Moreover, Easterby-Smith et al. (2008) in their research introduce framework of inter-organizational knowledge transfer where most of the antecedents are similar. However, the important finding is that they divide firms into donor firm which shares knowledge and recipient firm which receives knowledge. Moreover, instead of network characteristics, Easterby-Smith et al. (2008) use term inter-organizational dynamics. Furthermore, they add complexity and tacitness as characteristics for knowledge. However, Wijk et al. (2008) includes all of this in knowledge ambiguity saying that it emerges the simultaneous effects of tacitness, specificity, and complexity. Figure below represents the framework.

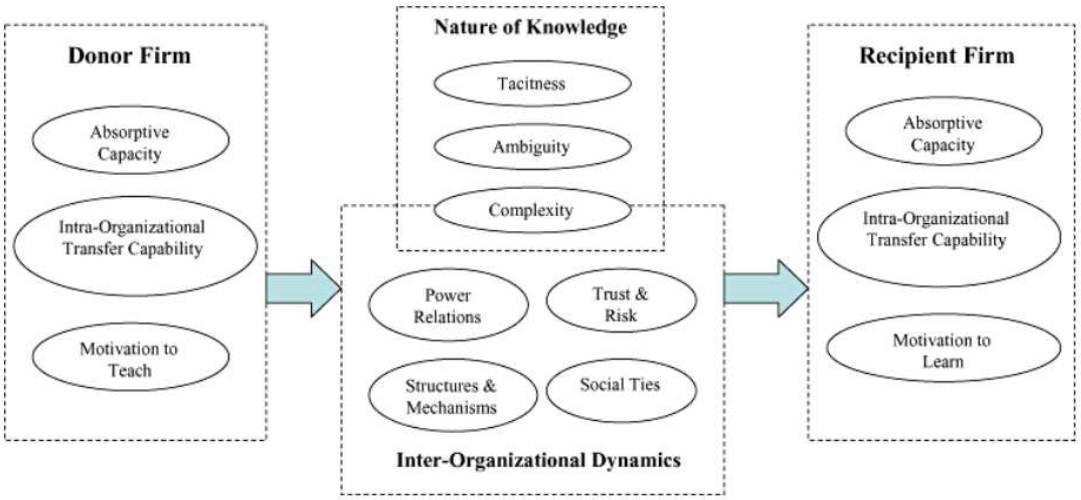

***Figure 15**. Inter-organizational knowledge transfer framework (Easterby-Smith et al., 2008).*

Figure 15 shows the knowledge flow from a donor firm to a recipient firm. An important thing that Easterby-Smith et al. (2008) highlight is motivation to teach and motivation to learn. They add that recipient has to be motivated to gain knowledge. Moreover, Hamel (1991) claims that motivation to learn is a key factor of the successful knowledge transfer, Ko et al. (2005) argue that motivation to teach is an equally important factor. Easterby-Smith et al. (2008) summarize that these factors might affect each other. For instance, lack of motivation to teach will probably decrease motivation to learn and vice versa. Thus, both factors must be considered as crucial antecedents for the process.

Further development of the inter-organizational framework has been done by Martikenaite (2011). She added consequences of the inter-organizational knowledge transfer to the framework of Easterby-Smith et al. (2008) who discussed antecedents of the process. Consequences of inter-organizational knowledge transfer refer to "learning performance" and "organizational performance". It is necessary to consider both since knowledge transfer is only completed when recipient firm uses gained knowledge and it has influence on company's performance. Hence, measuring these two parameters will evaluate the impact and success of knowledge transfer (Martikenaite, 2011). Figure below shows the framework.

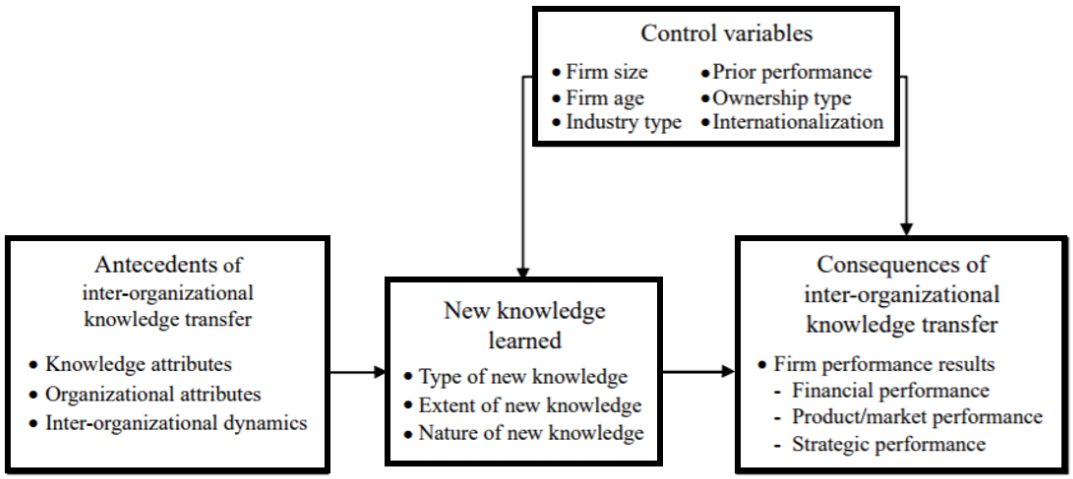

Figure 16. *Integrative framework of the antecedents and consequences of inter-organizational knowledge transfer (Martikenaite, 2011).*

Figure 16 illustrates integrative framework of the antecedents and consequences of inter-organizational knowledge. Moreover, it shows that this framework includes parts from Inter-organizational knowledge transfer framework (Easterby-Smith et al., 2008) and categories of antecedents highlighted by van Wijk et al. (2008). However, this framework focuses more on consequences rather than on antecedents of the process. Thus, the further literature review aims to create new framework of inter-organizational knowledge transfer focusing on antecedents gather from different sources. Moreover, consequences should be also a part of the new framework.

3.3 Antecedences and Consequences of Inter-Organizational Knowledge Transfer

In the current literature there is a plenty of information regarding antecedents of knowledge transferring process. They will be analyzed and based on that analysis some will be chosen as important antecedents for inter-organizational knowledge transferring process.

To begin with, factors of participating parties of knowledge transfer should be discussed closely. Table below represents antecedences related to a donor and recipient firm discussed in different sources.

Table 5. *Organisational characteristics*

	Easterby-Smith et al., 2008	van Wijk et al., 2008	Martikenaite, 2011
Age		+	+
Size		+	+
Decentralization		+	
Absorptive capacity	+	+	+
Motivation	+		+
Intra-organizational transfer capabilities	+		+

Table 5 represents characteristics which different authors thought might have potential impact on knowledge transfer. Below each aspect is discussed in more details.

Age of an organization is considered as determinant factor regarding knowledge transferring process. Wijk et al. (2008) argue that, even though some researchers do not recognize negative effect of old companies, there is still difference, and young companies could absorb knowledge faster and easier. Thus, to retain this advantage of a small and young firm many organizations tend to decentralize their operations.

Size of the company is considered to be a negative aspect in terms of knowledge transfer. However, there are plenty of studies (Dhanaraj et al., 2004; Gupta and Govindarajan, 2000; Laursen and Salter, 2006) which have found a tendency that size of a company has positive influence on the process. Thus, Wijk et al. (2008) claim that overall effect on the process is mixed. However, there is no explanation why it is this happening. Perhaps, based on Nonaka's SCEI model, if an organization is rather big, they have more explicit knowledge or more written knowledge, whereas in a small company most of knowledge is bundled with people. Hence, such knowledge is much more difficult to transfer. Thus, a big size of a company can be a problem for knowledge transfer. However, if this company has been working on organizational learning it can also have positive impact.

Decentralization means giving more decision-making power to smaller units. Decentralization has positive impact on knowledge transferring process. Wijk et al. (2008) add that separated units share knowledge much easier and faster. However, in their research they did not find evidence that age and decentralization have any impact on knowledge transfer

Summarizing, van Wijk et al. (2008) claim that based on their research firm's size has positive impact on the knowledge transfer. However, it is not that dramatic.

Next, absorptive capacity is one of the most important factors regarding knowledge transfer (Martikenaite, 2011), introduced by Cohen and Levinthal (1990). They claim that absorptive capacity means the ability of a firm to recognize, absorb and apply knowledge from external sources. For the recipient firm absorptive capacity is crucial since it has to figure out what knowledge is important. On the other hand, donor firm needs absorptive capacity to recognize value in knowledge transferring process to the recipient firm (Easterby-Smith et al., 2008). Hence, absorptive capacity plays crucial role for intra- and inter-organizational knowledge transfer.

Moreover, intra-organizational transfer capabilities are highly important since, for a recipient firm, it is not enough to receive knowledge from a donor firm. Knowledge has to be spread among employees in a recipient firm in order to influence the firm's performance. On the other hand, the donor needs intra-organizational transfer capabilities in order to be able to deliver knowledge to the recipient in the proper form. Moreover, the donor firm should carefully evaluate what knowledge could be shared.

Furthermore, motivation is crucial for the knowledge transfer. Easterby-Smith et al. (2008) claim that motivation from both parties is a necessity for the successful knowledge transfer. Because lack of motivation makes the process not only much longer, but the whole process might fail, if any of the parties is unmotivated. Furthermore, lack of motivation on one side decreases motivation on the other. Low motivation of the donor firm usually makes it difficult for the recipient firm to access needed knowledge. On the other hand, lack of motivation on the recipient side has impact on the recipient's ability to absorb and diffuse knowledge (Martikenaite, 2011). Thus, even though the recipient side gets core knowledge, it would not have an impact on their performance without motivation.

Figure below shows donor firm's antecedents and recipient firm's antecedents regarding knowledge transferring process. It includes all the previously discussed antecedents from three different frameworks.

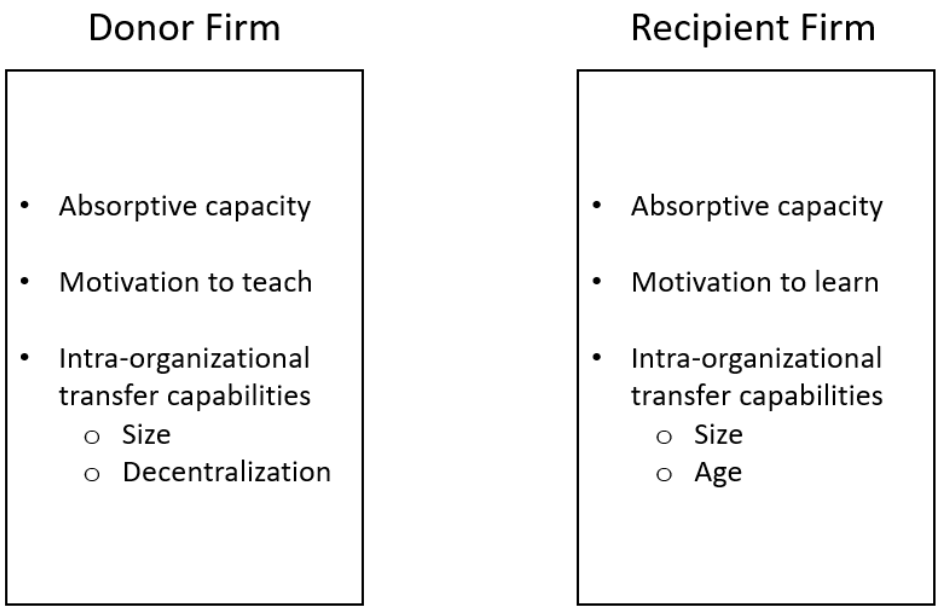

Figure 17. *Donor and recipient firms' antecedents to knowledge transfer.*

Figure 17 shows three core antecedents for each party. Size, decentralization and age are included in intra-organizational transfer capabilities since they do not have straight impact on inter-organizational transfer. However, it is evident that they influence intra-organizational transfer capabilities. Moreover, according to Wijk et al. (2008), age of the company has more impact on the recipient company since old firms tend to have problems acquiring new knowledge, whereas it seems to have insignificant impact on donor's capabilities. Furthermore, decentralization has bigger impact on intra-organizational transfer capabilities of the donor firm. Moreover, bigger size of a company in case of the donor firm improves intra-organizational transfer capabilities, whereas big size of a company makes it more difficult for the recipient firm to absorb and diffuse knowledge.

Next part of the framework is knowledge characteristics. Regarding this topic researchers agree with each other that a crucial antecedent of knowledge transfer process is ambiguity of knowledge (Wijk et al., 2008; Martikenaite, 2011, Easterby-Smith et al., 2008). However, some include in this term tacitness, specificity and complexity, whereas, others separate it as other characteristics. Table 6 shows Knowledge characteristics.

Table 6. *Knowedlge characteristics*

	Easterby-Smith et al., 2008	van Wijk et al., 2008	Martikenaite, 2011
Tacitness	+	+	+
Complexity	+	+	+
Specificity	+	+	+
Institutional embeddedness			+

Table 6 shows that authors agree on three main characteristics of knowledge. Tacitness refers to tacit knowledge meaning of how strongly knowledge is bound to human experience. As discussed in the previous section, tacit knowledge is much more difficult to transfer than explicit knowledge (Nonaka and Takeuchi, 1995). Degree of knowledge complexity is evaluated by how many different competences are combined (Martikenaite, 2011). Specificity of knowledge refers to how many different units oversee knowledge. The opposite of specificity is uncertainty when knowledge is spread among many units. Martikenaite (2011) claims that institutional distance between parties makes it more difficult to transfer knowledge. Thus, all the factors have clear impact on knowledge transfer and could be included as antecedents to the framework. According to Simonin (2004), ambiguity is negative for knowledge transfer. Moreover, all these parameters are more related to tacit knowledge than to explicit. Thus, figure below summarizes antecedents of knowledge.

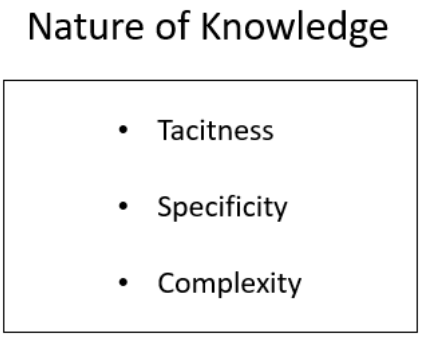

Figure 18*. Nature of knowledge in terms of knowledge transfer.*

Figure 18 represents antecedents for knowledge transfer related to the nature of knowledge. It is possible to unite these three terms and call it knowledge ambiguity. However, dividing it to three components makes it easier to understand.

Last groups of antecedents refer to the inter-organizational dynamics. Although, Wijk et al. (2008) name it network characteristics, the meaning is the same. Because two or more parties are included to the process, it is crucial to consider relations among them. Table below shows literature review on this topic. Table below shows that researchers agree with many points even though sometimes they name it differently.

Table 7. *Inter-organizational dynamics.*

	Easterby-Smith et al., 2008	**van Wijk et al., 2008**	**Martikenaite, 2011**
Number of relations		+	
Centralized position		+	
Power relation	+	+	+
Trust & Risks	+	+	+
Shared vision and system		+	
Social ties	+	+	+
Structure & Mechanisms	+		+
Cultural distance		+	

Table 7 shows important antecedents of inter-organizational dynamics. First, number of relations between firms increases accessibility to important knowledge. Because,

more units can communicate with more units, it is more likely that some of them will succeed (Gupta and Govindarajan, 2000). Thus, it is better when several units are involved in the knowledge transferring process from the both sides. Additionally, a centralized position makes it easier to gather that knowledge from different units and allocate it to one unit which is going to use it. Wijk et al. (2008) name two of these characteristics as structural properties and others are aspects of social network.

According to Easterby-Smith et al. (2008), the donor and the recipient are usually in a situation with of power asymmetry. The pace of knowledge transfer usually depends on the side which has more power in the relationship. Usually the donor has more power. However, when the recipient realizes that there is not much to learn, the basis for cooperation might disappear (Martikenaite, 2011).

Social ties refer to closeness between partners. Knowledge transferring usually happens between organizations with mutual interest (Hansen, 1999). Moreover, usually these companies are partners. However, there could be different level of partnership and tie strength refers to this. Furthermore, knowledge transfer usually makes social ties stronger. It is evident that knowledge transfer process goes much easier if companies have high level of communication and frequent interaction. That happens because, if social ties are strong, companies are more willing to make extra effort to help knowledge seekers or receivers understand and exploit newly acquired knowledge (Wijk et al., 2008).

Furthermore, trust is quite similar aspect which usually comes together with tie strength. When companies have high trust level, they usually have good tie strength. Since oftentimes knowledge is a crucial resource, sharing it is strictly prohibited. However, if companies are working together and have trust for this, it will make the process easier (Wijk et al., 2008). Moreover, trust refers also in the ability of another firm. Especially if the case is about new technology, then a company which shares knowledge must trust their partners. Easterby-Smith et al. (2008) add that both parties take risks as well. For instance, the donor firm risks sharing core knowledge which might lead to lose of core competence. However, the recipient firm's risk is that the knowledge that they get might be useless or low quality. Thus, trust is important in case of inter-organizational knowledge transfer since it creates sense of security for both parties (Dhanaraj et al., 2004).

Structure refers to the nature of relationships between parties and the transfer mechanisms which are established in these relationships (Easterby-Smith et al., 2008). Often the donor and the recipient are in a strategic alliance, otherwise it is difficult to imagine significant knowledge transfer. There could be different types of alliances. It could be non-equity, for instance licensing, or equity arrangements. Lyles and Salk (1996) argue that shared ownership joint ventures are more successful in knowledge transfer since all other antecedents, which were discussed previously, are quite on a high level regarding trust, number of interaction and social ties.

Another crucial point in inter-organizational transfer process is cultural distance, even though not all researchers emphasize that. Palich and Gomez-Mejia (1999) argue that cultural distance significantly decreases the donor firm's ability to share core knowledge and capabilities to foreign market. Cultural distance might lead to misunderstanding between two companies, hence making it difficult for the recipient firm to get important knowledge (Wijk et al., 2008).

On the contrary to cultural difference that has negative impact on inter-organizational knowledge transfer, shared vision and system influence positively the process. Shared vision enhances mutual understanding (Wijk et al., 2008).

Thus, every antecedent which is discussed above has an impact on the knowledge transfer. Hence, they should be included and considered during inter-organizational

knowledge transfer process. Figure below represents characteristics of inter-organizational dynamics.

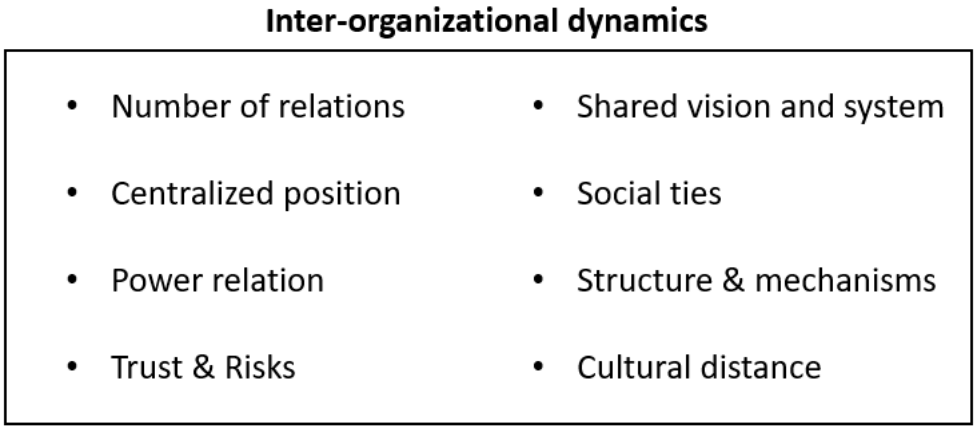

***Figure 19**. Inter-organizational dynamics.*

Figure 19 shows crucial characteristics of inter-organizational dynamics. By evaluating these characteristics, one can estimate future success of the knowledge transferring process.

Even though some researchers do not discuss consequences of the knowledge transferring process (Easterby-Smith et al., 2008), others claim that both intra- and inter-organizational knowledge transfer have positive impact on organizational performance and innovativeness (Wijk et al., 2008; Lyles and Salk, 1996). Moreover, Martikenaite (2011) claims that the process has a positive influence on organizational performance and on learning performance. Furthermore, knowledge transfer is a two-stage process. First step is acquisition of new knowledge and second is exploitation of it. Scholars (Cohen and Levinthal, 1990) add that some knowledge could cause positive changes immediately after being transferred, whereas, mostly it could have impact on the organizational performance only in a long-term perspective. Especially this applies to multicultural knowledge transfer since transferred knowledge should be adopted to the new environment. Overall, the consequences of knowledge transferring process are difficult to measure. However, three main aspects should be included in the framework:

- Learning performance
- Organizational performance
- Innovativeness

First, Lane et al. (2001) distinguish learning performance as an ability of a firm to understand and assimilate its partners' knowledge. Learning performance refers to the first step of the knowledge transfer - knowledge acquisition. Thus, the more knowledge is being transfer to a firm from external sources, the better the process goes. Furthermore, when two companies work closely with each other and constantly transfer knowledge, they develop strong connections and improve the process with time. However, that works as well

for one party of the process since the experience it gets in the relationships with one company can help in future knowledge transferring process. Moreover, inter-organizational knowledge improves intra-organizational knowledge transfer (Wijk et al., 2008).

Second, organizational performance refers to the second phase of knowledge transfer. Because it is not enough to receive knowledge from the donor firm, it is critical that it has impact on the recipient firm performance. Transferring knowledge contributes to the development of new capabilities which lead to competitive advantage (Szulanski, 1996). It could be new product or processes, or a new marketing strategy. Furthermore, Wijk et al. (2008) claim that, even though intra-organizational knowledge transfer showed more influence on firms' outcomes, it without a doubt has a positive impact on a company's performance.

Third, Wijk et al. (2008) argue that inter-organizational knowledge transfer is much more effective in terms of innovativeness compared to intra-organizational transfer because units within a company tend to focus on what they already know and that is why it is more likely to bring short-term performance. Because exchanging knowledge between firms would most likely increase innovativeness and lead to new products or projects, it will have impact on company's performance in a long-term.

Overall, evaluating consequences is an important step in the knowledge transferring process. It is crucial for managers to understand what such an intense alliance brings to the firm. Moreover, if the outcomes are not great, the reason behind it must be tracked and some actions should be implemented. Figure below represents inter-organizational knowledge frame work considering all previous discussions.

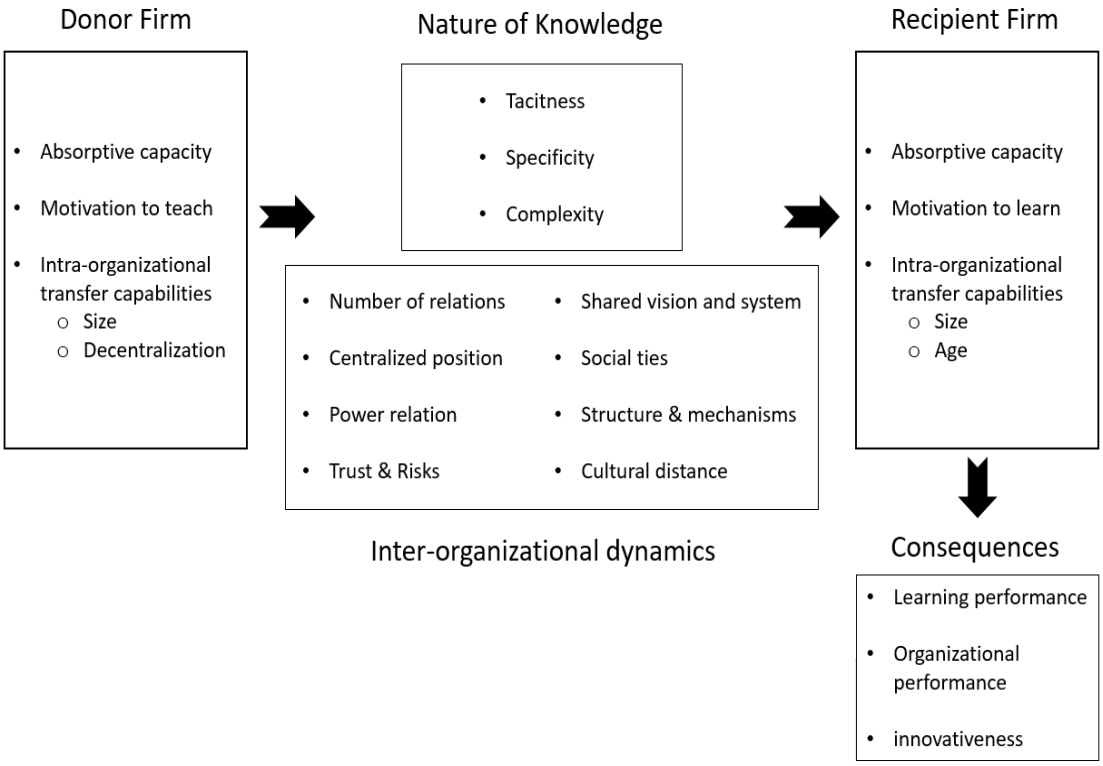

Figure 20. *Antecedents and consequences of inter-organizational knowledge transfer.*

Figure 20 shows antecedents and consequences of the process. These antecedents have different impact on the consequences and overall success of the process. However, it is also true that with a good approach some of the negative antecedents could be overcome. Furthermore, since knowledge transfer is usually a long-term process, antecedents and dynamics always change.

To sum up, for managers in charge of the knowledge transferring process it is important to consider these antecedents, because, even though some of them are unchangeable, it is still possible to decrease their negative impact or on the other hand to enhance positive.

4. MOCK-UPS

4.1 Prototyping

Nowadays companies try to make their businesses as efficient as possible in order to reach competitive advantage. Thus, all different sides of the business are taken into account and of course one of the key aspects is product design process. Turney (1991) claims that, after product has been designed, around 60-80 percent of the final cost are locked in. Figure 21 represents his idea.

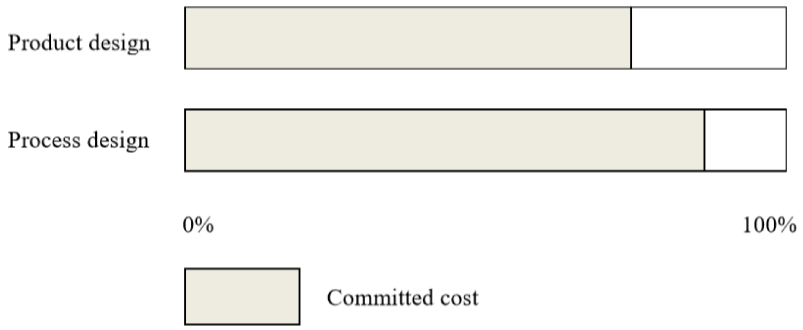

Figure 21. *The critical role of the design (Turney, 1991).*

Figure above shows that most part of the final cost is committed after product design stage. Furthermore, after process design stage around 90 percent of the cost is committed (Turney, 1991). Thus, it is obvious that companies try to influence the cost of the product during the product development process. Moreover, according to Atkinson et al. (2004), committed cost accumulate in the early stage of product development. Thus, decisions which are made in early stages of product development process have huge impact on the final cost. Hence, it is better for a company's success if those decisions are made based on the valid information. However, Turney (1991) argues that cost information is usually reported too late. Hence, it does not have big impact on the final cost. Loch and Kavadias (2011) add that companies test their products too late and too little. Hence, they do not have valid information regarding product cost at the time when it still could be changed dramatically. One solution to this problem is prototyping since even in early stage of product development process it gives some information that could improve decision making process. Prototype is a model of a product, made to help developers to get deeper understanding of the product and resolve one or more issues during production process (Otto and Wood, 2001). Prototypes could be different types from simple sketches to fully functional mechanisms (Ulrich and Eppinger, 2012). Hence, prototyping is the process of developing any type of a prototype related to a product.

Prototyping became popular in 70s and early 80s. Prototypes were used in all stages of product development (Otto and Wood, 2001). However, sometimes it was only increasing costs due to high costs of prototypes. Thereby, there was a need for different kinds of prototypes for different purposes. According to Ulrich and Eppinger (2012), there are two main classifications of prototypes. Dutson and Wood (2005) claim that the first one divides prototypes to analytical and physical, whereas the second one divides prototypes to focused and comprehensive. Figure below shows the first classification where prototypes are divided into two groups: analytical and physical.

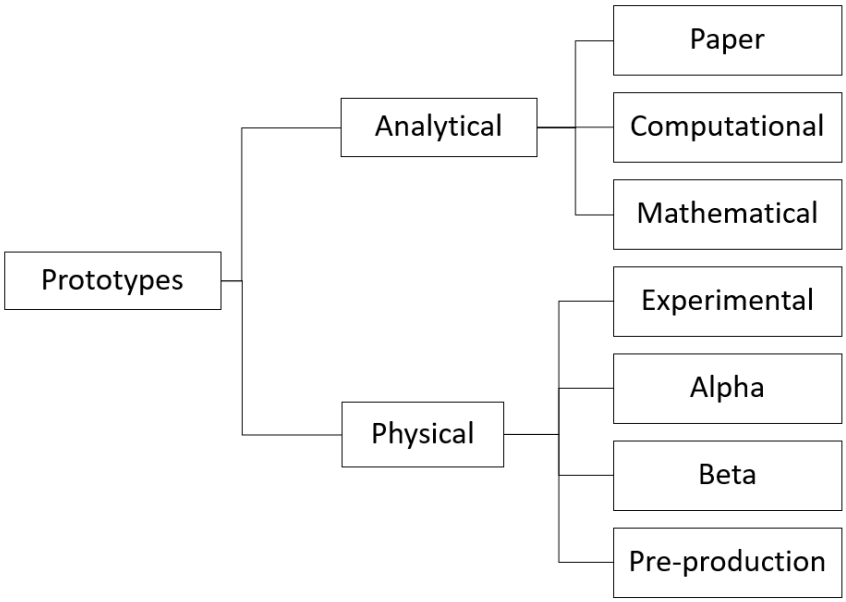

Figure 22. *Taxonomy of prototypes (Yang and El-Haik, 2003).*

Figure 22 shows a big variety of prototypes. According to Otto and Wood (2001), analytical prototypes represent products through intangible, mathematical or visual manner. Here features of a product are mostly analyzed, rather than built. Physical prototype is a simplification of a product concept (Otto and Wood, 2001). Each prototype has different purpose and functionality. For instance, experimental prototypes are made as a simple simulation of a product using cheap materials. It is made very quickly, and the purpose of this type of prototype is simple demonstration of general ideas regarding the future product. However, alpha prototypes usually are made using same materials as the final product. Shape and most of design features are made closely to the final product. Moreover, alpha prototypes have some functionalities of the final product. On the other hand, a beta prototype is almost a full copy of a product. It has all the functionalities and is made of same materials. However, it might be constructed using different production process. The last type of physical pretotypes is pre-production prototype. It is a final version of the product which is constructed with final production process.

Second taxonomy, which is suggested by Ulrich and Eppinger (2012), divides prototypes into two categories: focused and comprehensive. A comprehensive prototype represents most or all the functionalities that a final product has. A comprehensive prototype is one that usually is given to a customer to get the final agreement or negotiate some small design or technical moments. Hence, it is usually used in the last stages of product development process. On the contrary, focused prototypes represent one or a few features of the product. Ulrich and Eppinger (2012) claim that it is a common practice to build two prototypes when one shows how the product works from the technical point of view whereas the second one represents the design. Focused prototypes are used in all stages of product development process.

Both categorizations could be combined. Hence an analytical prototype can be focused or comprehensive, same for physical prototypes. However, Ulrich and Eppinger (2012) add that focused prototypes could be both analytical and physical, but comprehensive prototypes in most of the cases must be physical.

Based on these two categorizations it is possible to show road map and indicate the probable position of different prototype types. Figure 23 shows that rough road map of prototypes.

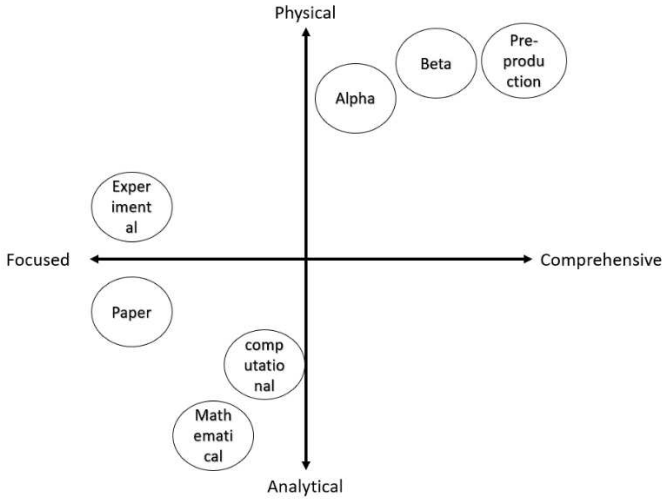

Figure 23. *Types of prototypes (Ulrich and Epinger, 2012).*

However, it is evident that in each case a type could be more focused or come comprehensive and it depends on the needs of the product development team.

4.2 What prototypes are used for

According to Otto and Wood (2001), different subgroups of a product development team can use prototypes for different purposes. It happens because prototypes bring a variety of benefits and different types serve different purposes. Therefore, it is important to understand potential benefits of each type of the prototype and the appropriate time to make it. Table below shows that researchers mostly agree on purposes of prototypes

Table 8. *Purposes of prototypes*

Purpose	Otto and Wood (2001)	Ulrich and Eppinger (2012)
Learning		+
Communication	+	+
Integration		+
Milestones/scheduling	+	+
Demonstration	+	

Table above shows what prototypes are used to. According to Ulrich and Eppinger (2012), learning is the most common reason to make a porotype. It helps product development team to find answers for two most common questions: “Will it work?” and “Will it meet the customer needs?”. Although Otto and Wood (2001) name it feasibility, the arguments behind are quite the same. This purpose serves the same needs: to understand if it will work and if it meets the customer needs. Hence, these two purposes could be combined as one.

Otto and Wood (2001) claim that prototypes enhance communication with all kinds of shareholders of the product. Hence, communication is highlighted as a purpose. Ulrich and Eppinger (2012) add that it is particularly true for physical prototypes since it easier to understand the ideas of the product for all the parties, whereas analytical prototypes could be too complicated for someone who is not working on it.

Ulrich and Eppinger (2012) claim that prototypes are often used to ensure that different parts of the product work fine with each other. They call it integration purpose. It is needed because sometimes there are many subgroups of production process and when the groups work separately different groups might come up with a solution which does not match with a solution of another group. For instance, when the design of a product does

not allow some technical feature. For this purpose, comprehensive prototypes work the best since they have most or all the features of the product.

Another purpose of prototypes is scheduling or milestones. Prototypes help to understand schedule for the product development team. Moreover, Otto and Wood (2001) add that prototypes speed up decision making process and hence, the whole process.

Furthermore, it is a natural wish of top-managers and customers to see how well development process is going on. Usually the best way to show this is prototypes, and that is the last purpose - demonstration.

It has been mentioned that some prototypes obviously serve better for some purposes than others. Hence, it is important to distinguish what prototypes correspond to what purpose. Figure 24 shows comparison of prototypes.

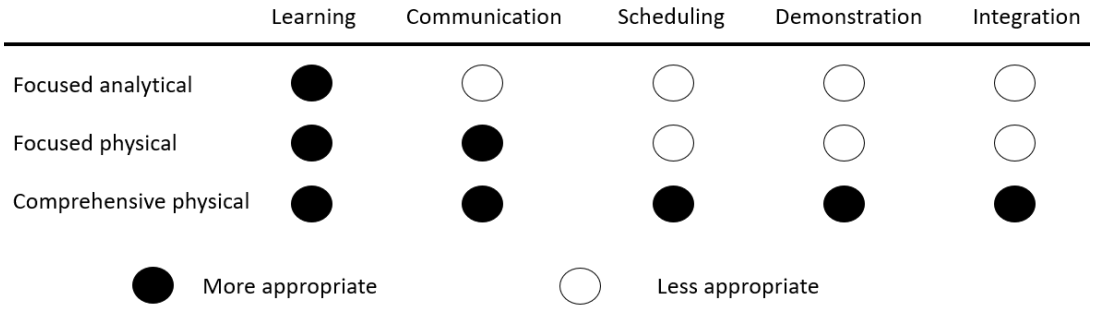

***Figure 24**. Appropriateness of different types of prototypes for different purposes (Ulrich and Eppinger, 2012).*

Figure above shows that focused analytical prototypes are more appropriate for a learning goal, whereas in other cases they are less appropriate than physical. Moreover, focused physical prototypes are more appropriate for learning, communication and demonstration. However, it is important to remember that focused prototypes represent only one or a few features of the product. Hence, it is evident that only comprehensive physical prototypes are well suited for integration and scheduling.

Another way to compare prototypes with each other is by comparing their fidelity. According to Preece et al. (2002), fidelity of prototypes shows how close a prototype is to the final product. Hence, a high-fidelity prototype looks like a final product and has most or all the features of the final product. On the other hand, a low-fidelity prototype is a very simple model of a product and is usually made quickly using cheap materials. This classification is quite similar to focused and comprehensive prototypes. However, the important difference is that focused prototypes could be low-fidelity and high-fidelity. Table below provides comparison between low-fidelity and high-fidelity prototypes.

Table 9. *Comparison between low and high-fidelity prototypes (Modified from Preece et al., 2002).*

TYPE	ADVANTAGES	DISADVANTAGES
Low-fidelity prototypes	• Low development cost • Useful communication device • Proof of concept • Easy and fast to make	• Limited error checking • Limited options of the product • Requires many assumptions
High-fidelity prototypes	• Full functionality of the product • Similar design • Could be presented to customers	• Quite expensive • Inefficient for proof of concept

Table 9 shows that low-fidelity prototypes are better for proving concepts and communication. On the other hand, high-fidelity prototypes are more appropriate for presenting products for important stakeholders. High-fidelity prototypes are much more expensive. Hence, it takes too much resources to make two or three different high-fidelity prototypes to show some different ideas whereas low-fidelity prototypes perfectly suit this purpose.

Thus, it is possible to improve taxonomy of physical and analytical prototypes by addicting there a low-fidelity and high-fidelity scale. Figure 25 shows classification of physical and analytical prototypes.

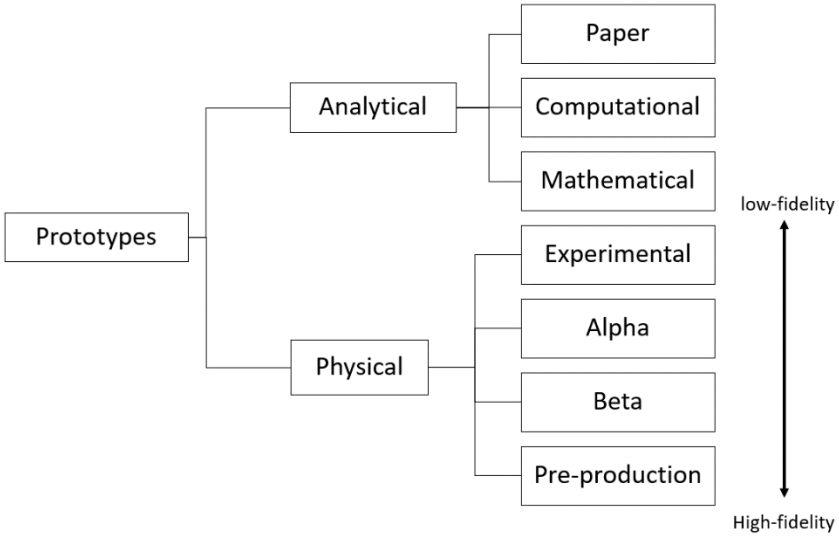

Figure 25*. Types of prototypes (Yang & El-Haik, 2003 and Preece et al., 2002)*

Figure above shows that experimental prototypes are usually have low-fidelity since it is a cheap simple imitation of a product. On the contrary, pre-production prototypes have the highest fidelity since they are basically the final products. Thus, the all degrees and purposes of prototypes have been discussed.

4.3 Product development process

Another important thing that must be discussed regarding prototypes is product development process (PDP). It has already been mentioned that some prototypes are better for different stages of PDP. However, first it is important to introduce the concept of PDP.

Nowadays in the world of high competitiveness it is extremely important for companies to develop their product as efficient as possible. Thereby companies focus on their product development. According to Ulrich and Eppinger (2012), product development is the set of activities starting with the idea or opportunity and ending in the production or sale of a product. Furthermore, Otto and Wood (2001) add that this set includes also business case analysis, marketing efforts and technical engineering design activities. They also claim that development process includes manufacturing process, when the product is physically made.

However, many companies have failed in their product development. Because of wrong sequence of actions (Cooper, 2008). Thus, a simple guidebook was suggested and developed mainly by Robert Cooper, which consists of several steps aiming to increase the efficient of product development process. Cooper (2008) explains that in the stage-gate model (Figure 26).

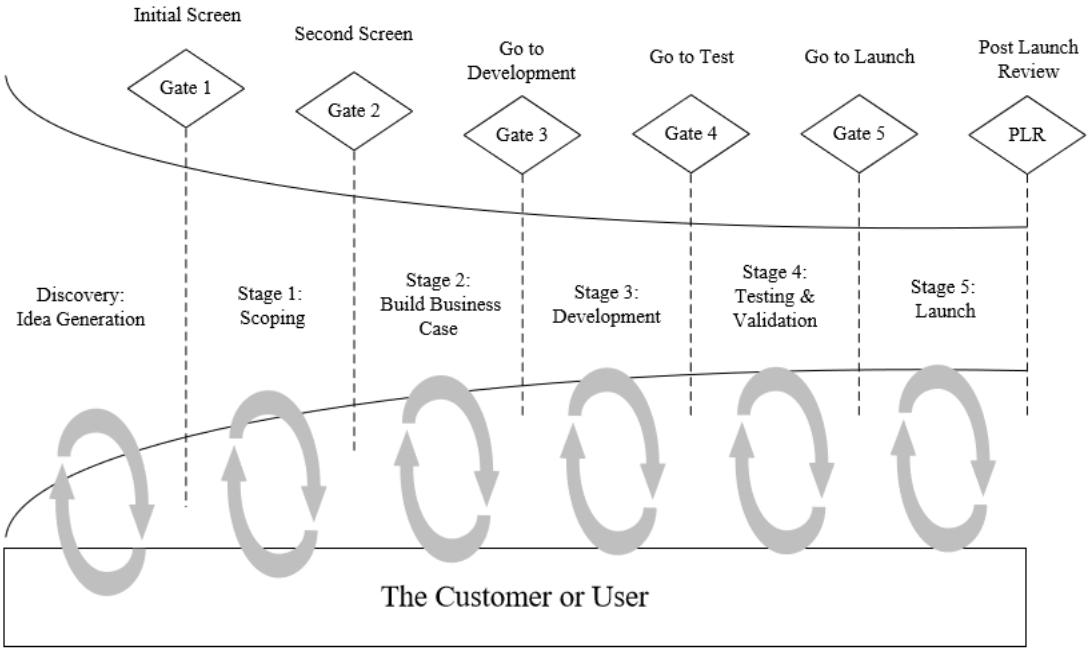

Figure 26. *Stage gate model (Cooper, 2008).*

Figure above shows that stage-gate model consists of 5 stages and 6 gates and the post launch review in the end. Each gate is needed to estimate information collected during the previous stages and to make new ideas which could be applied in future. They also serve as a quality control.

During the first stage small groups of people with some technical and marketing knowledge begin the research with estimating of preliminary market situation, technical ideas and business ideas.

The second stage is focused on deeper research which leads to building a business case. This stage consists of more detailed analysis including market research, technical and manufacturing assessment, study of financial and business aspects. Usually in this stage a more competent team is required.

During the development stage plans from previous steps are executed. Usually there could be some simple test with customers using prototypes. Moreover, this stage includes creating a marketing plan. The fourth stage is testing and validation. This phase consists of several tests which aim to find issues with a new product, furthermore, some marketing and sales trials. As a result, the product is absolutely validated and ready for production. The final stage consists of full production and market launch.

Thus, due to different purposes and advantages of prototypes it is possible to allocate types of prototypes in different stages of PDP. Figure below shows in which stage some prototypes fit better.

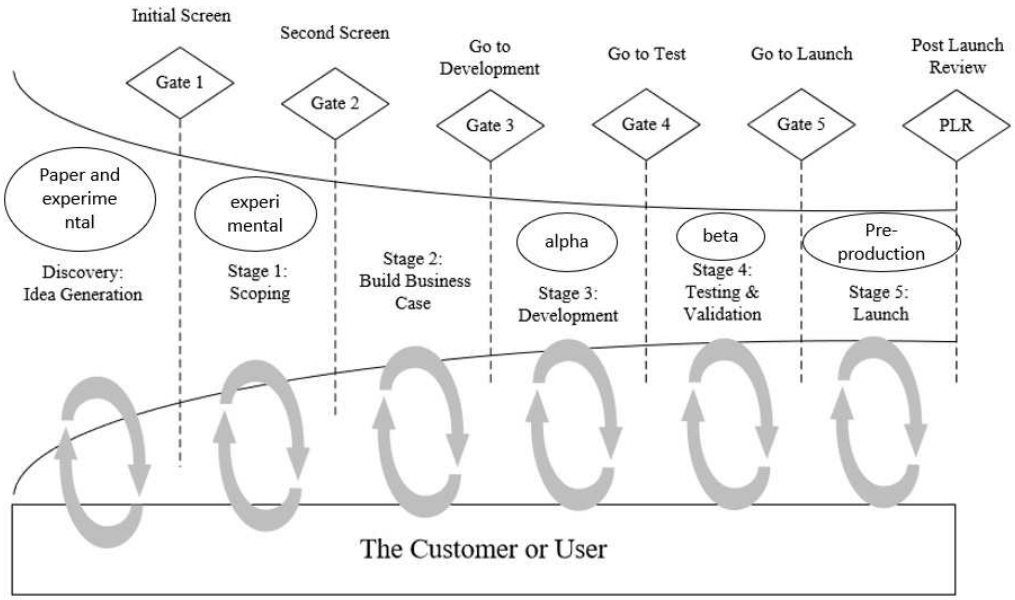

***Figure 27**. Prototypes in stages gate model (Pour, 2015).*

Figure 6 shows that each stage has an appropriate type of prototypes which suits better goals of the stage, but one. According to Pour (2015), existed prototypes do not fully satisfy needs of the development team for the stage 2. Because experimental prototypes have their fidelity too low and on the other hand alpha prototypes are too complicated for that stage yet. Thus, Pour (2015) suggests fully functional mock-ups as a perfect tool for the second stage.

4.4 Fully Functional Mock-ups

To begin with, mock-up is a slightly different term than prototype. Mock-up is usually a simple copy of a product which represents design and structure of the product. It is made from cheap materials and serves for goals such as demonstration. However, it does not have functionality of the final product. In the classification of Yang and El-Haik (2003) it would stay before experimental prototype. On the other hand, Pour (2015) claims that fully functional mock-up (FFM) is located between experimental and alpha prototypes. Figure below shows position of fully functional mock-up in the classification.

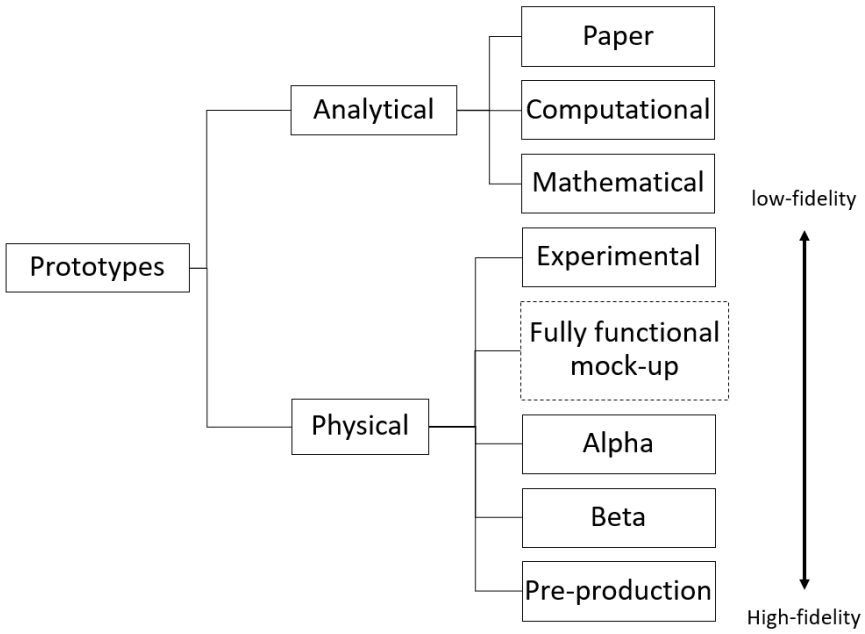

***Figure 28**. Positioning of fully functional mock-ups (Pour, 2015).*

Figure 28 shows that fully functional mock-up has higher fidelity that experimental prototype. Pour (2015) claims that a fully functional mock-up is made of cheap materials like wood and, as well as experimental prototypes, represents design. However, it also has functionality of a final product. Hence, it fulfils the huge gape in the classification between experimental prototypes and alpha prototypes.

Furthermore, it is important to distinguish other degrees of fully functional prototypes. For instance, fully functional mock-up is usually focused since it shows a few functionalities of the final product. However, the features that it focuses at are shown close enough to a final product. Hence, in terms of focused and comprehensive it locates in the middle. Moreover, it is important to understand what purposes it suits better. Figure below shows comparison of FFM and different types of prototypes.

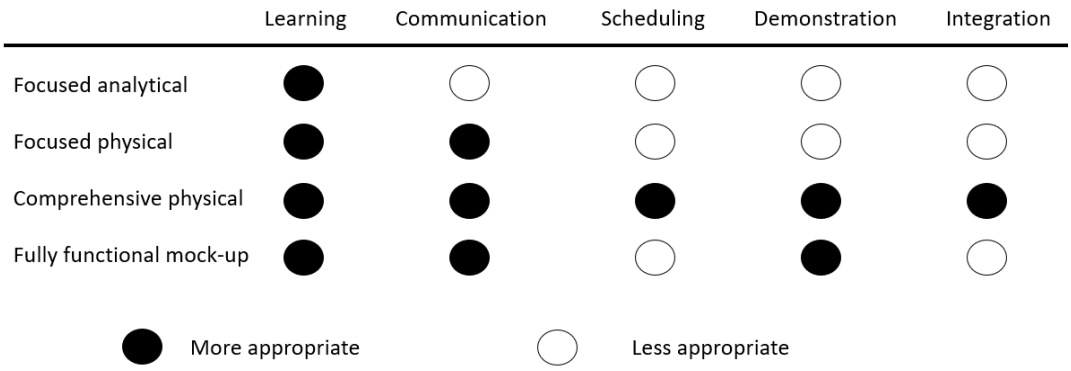

Figure 29. *Purposes of fully functional mock-ups.*

Figure 29 shows that because FFM has better functionality that focused prototypes it suits for demonstration quite well. However, still it is not that good for integration and scheduling process since it is still closer to concept proof version.

Moreover, it is important to evaluate fully functional mock-up in terms of fidelity. Table below shows advantages and disadvantages of fully functional mock-ups.

Table 10. *Advantages and disadvantages of fully functional mock-ups (Adapted from Pour, 2015)*

TYPE	ADVANTAGES	DISADVANTAGES
Low-fidelity prototypes	• Low development cost • Useful communication device • Proof of concept • Easy and fast to make	• Limited error checking • Limited options of the product • Requires many assumptions
High-fidelity prototypes	• Full functionality of the product • Similar design	

Table 10 shows which advantages and disadvantages fully functional mock-up gets from low-fidelity prototypes and high-fidelity prototypes. Because it is made of cheap materi-

als, it is evident that the cost of development is cheap. On the contrary it has full functionality. However, it might have only one or some features of the product, depending on what the production team wants to test. The similarity of the design depends on the needs as well. Moreover, the biggest benefit is that it does not have disadvantages of high-fidelity prototypes which require too much effort and resources to make. Hence, it is a perfect tool for the second stage (Pour, 2015). Figure below shows the position of the fully functional mock-up in the stage gate model.

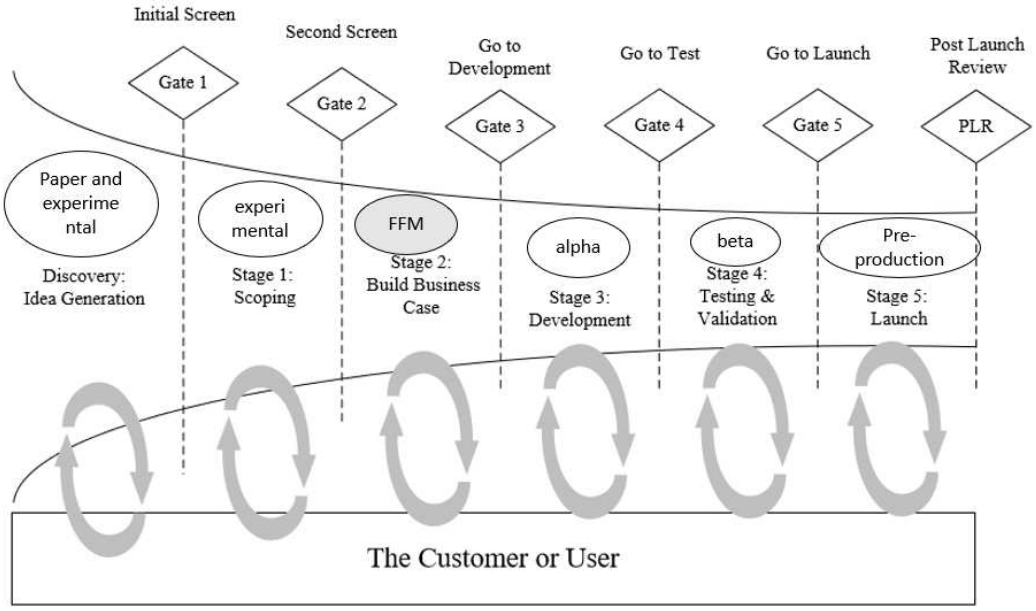

***Figure 30**. Utilization of mock-up and prototype in stage gate model (Pour, 2015).*

Fully functional mock-up suits Stage 2 the best since it can provide more valuable information for the product development team then an experimental prototype and still does not require too much resources as an alpha prototype. However, fully functional mock-up could be useful in the other processes as well.

4.5 Mock-ups as a tool for knowledge transferring process in outsourcing

Thus, fully functional mock-ups have more purposes than simple mock-ups. Fully functional mock-up can be useful in many other situations and is a powerful tool in managers hands. As discussed in previous chapters outsourcing process is quite complicated. Fawcett (2014) claims that an important part of the process is knowledge transferring from an outsourcer to an outsourcing company. It is evident that for different types of outsourcing the knowledge transferring process is very different. Figure 31 shows different types of outsourcing and how they are related to the knowledge transfer.

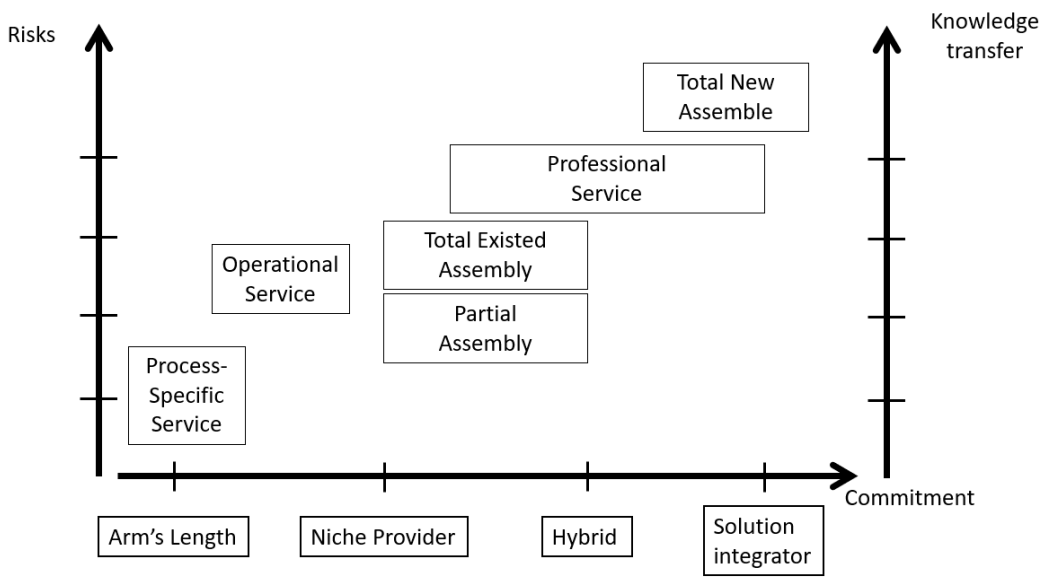

***Figure 31**. Location outsourcing types regarding risks, knowledge transferring and relationships with suppliers.*

Figure above shows that different types of outsourcing require different amount knowledge to be transferred. Moreover, it has been discussed that knowledge transferring process requires high collaboration among companies. Thus, it is logical that companies with higher commitment can manage difficult transferring process for total new assembly.

As discussed, total new assembly outsourcing sometimes requires some development processes from the outsourcing team. Usually it is regarding the production process since the product has to stay the same. However, according to Turney (1997), when the production process is not defined yet there is still room to cut costs.

Thus, to succeed in total new assembly outsourcing the donor should share a lot of knowledge. Usually knowledge transferring process enhances knowledge creation process (Nonaka and Takeuchi, 1995). This happens because during knowledge transfer knowledge is being changed from tacit to explicit and back, according to Nonaka's (1994) model. However, this happens not only in a donor firm, but the same process goes with the recipient firm too. Figure 32 represents this process.

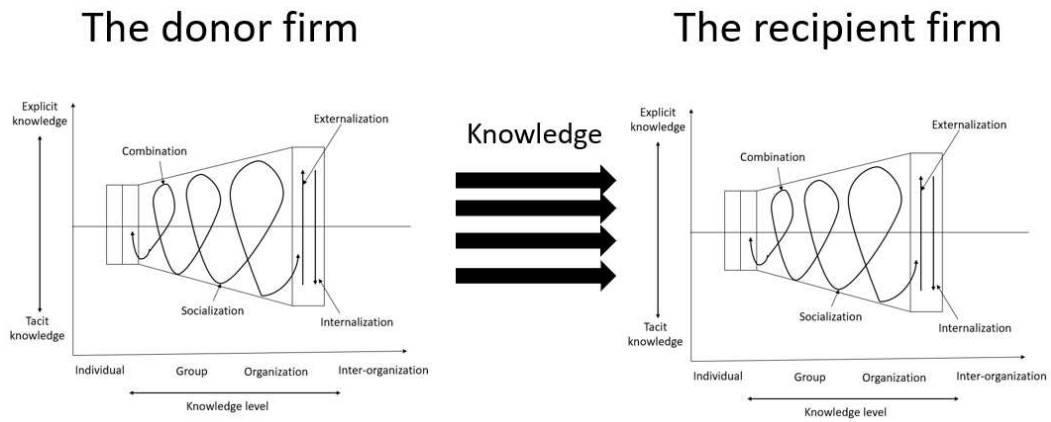

***Figure 32**. Spiral of organizational knowledge creation in donor and recipient firms.*

Figure above shows that the recipient firm gets significantly less knowledge than the donor firm has. However, it is obvious since some knowledge losses are quite predictable, and some knowledge is bounded to tight to the donor firm. Moreover, since there are just a few recipients, knowledge becomes on individual level. Thus, when it starts to spread through the recipient firm the knowledge creation process starts again. However, there might be some new important knowledge created. Thus, when knowledge transferring process for the total new assembly outsourcing is discussed, it is important that knowledge flows should go both ways. Thus, it will help not only to understand how the process going. However, it might lead to some innovations. Figure 33 shows that the knowledge flow should go to both directions.

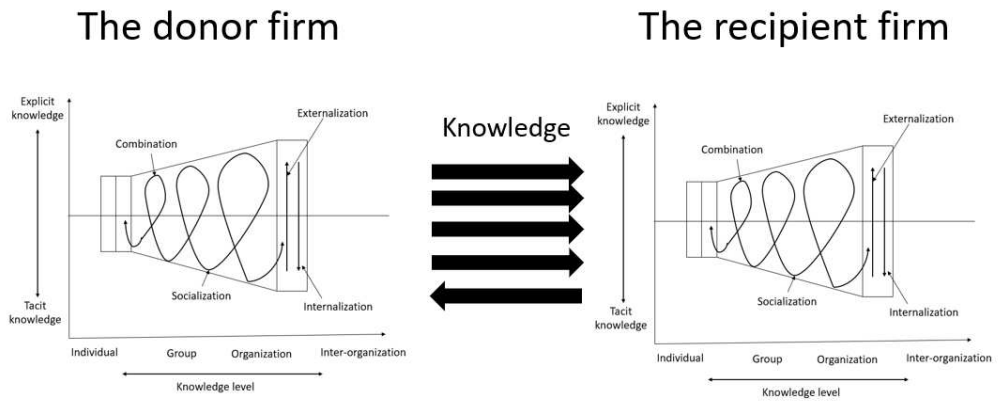

***Figure 33**. Knowledge transfer.*

Figure above shows that new knowledge should be transferred back to the donor firm. Thus, the recipient firm is not only learning from the donor firm, but it generates new knowledge as well. This knowledge might help the donor firm to improve their process or product. Moreover, it can lead to innovation. However, the donor firm usually is not interested in receiving any knowledge.

Moreover, as highlighted in Chapter 2 total, new assembly outsourcing requires knowledge transferring process. This outsourcing type usually happens between two firms with close relationships. Hence, according to antecedents of knowledge transferring process, it is evident that these firms have good background to succeed. Thus, again it is important for the successful outsourcing process that companies had hybrid or solution integrator types of relationships.

Traditionally knowledge flow goes from the donor firm to the recipient. However, as discussed, it should go both directions for better results. Figure 34 shows knowledge transferring process for the total new assembly outsourcing process.

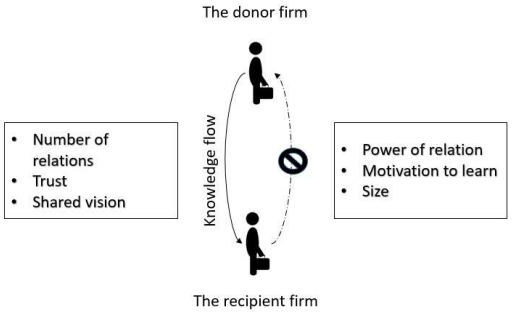

***Figure 34**. Knowledge transfer within total new assembly outsourcing.*

Figure 34 shows that the knowledge flow usually goes from the donor firm to the recipient. The box on the left shows what characteristics of inter-organizational dynamics enhance the process. The box on the left shows what factors prevent knowledge flow from the recipient to the donor firm.

In case of outsourcing the donor, firm is the one that tries to outsource, and the recipient is a supplier. Hence, usually the outsourcing company has the power of relations. Moreover, the outsourcing company usually is much bigger. These two things make it difficult to communicate knowledge backwards. Furthermore, the outsourcing firm usually does not feel the need to learn from its supplier. This makes the knowledge transfer even more problematic.

Thus, the recipient firm should develop a tool to enforce the knowledge flow towards the donor firm. The concept of fully functional mock-up could be a great tool for the recipient firm to communicate with the donor firm during the knowledge transferring process for the outsourcing goals. Because main purposes of FFM are communication and demonstration. Thus, FFM could provide important support for recipient firm's claims. Figure 35 shows that FFM enhance knowledge flow from the recipient to the donor firm.

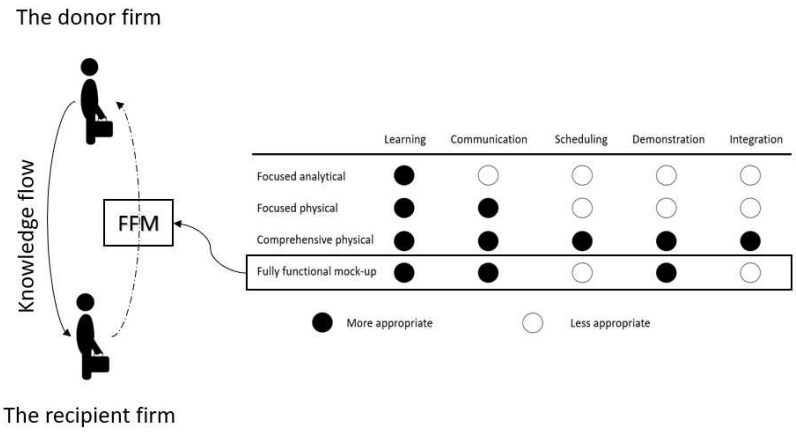

***Figure 35**. Fully functional mock-up as a tool for knowledge transfer.*

Figure 35 shows that functions of FFM learning, communication and demonstration help the recipient firm to communicate ideas to the donor firm. Because the donor firm usually has the power in the relations it is important for the recipient firm to support its ideas, and FFM is a great tool for it. Moreover, it is cheap and could be done quite fast without major resources. Thus, Figure below shows that the knowledge transferring process for the total new assembly outsourcing should be enforced by using FFM.

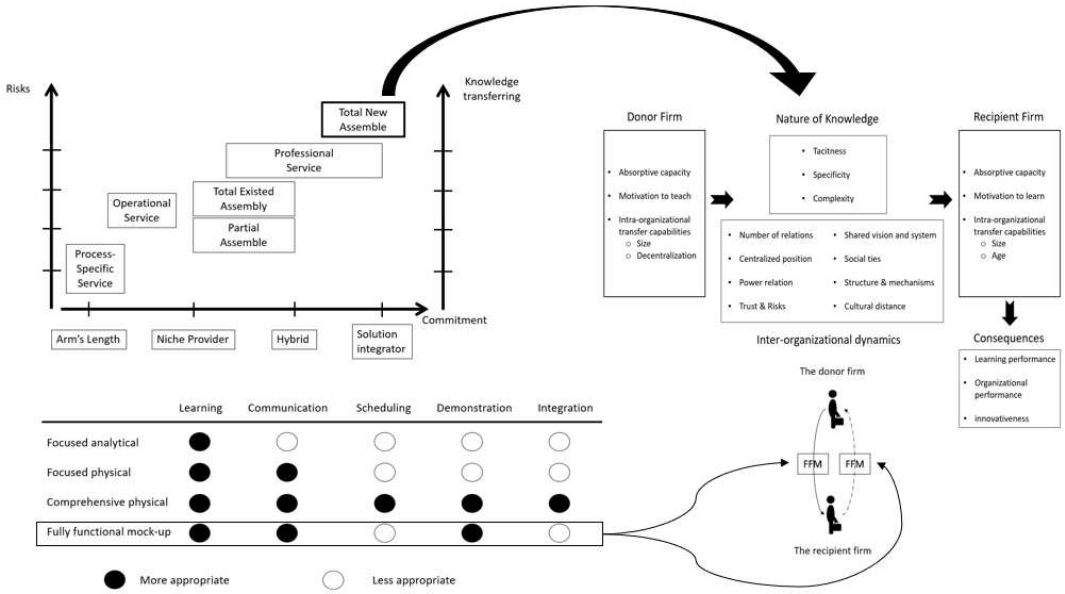

***Figure 36.** Fully functional mock-up as a tool for knowledge transfer in total new outsourcing.*

Figure above shows that FFM could be use fool tool for knowledge transferring from the donor firm to the recipient firm as well. Moreover, the example is made based on the total new assembly outsourcing. However, it is obvious that the same approach can be used for other types. The reason that this type is used as example since, as discussed, this type requires successful knowledge transferring process the most.

5. CASE COMPANY

5.1 The Case Company

The study was conducted in a case company. It is a hose assembly factory. In this thesis it will be referred as Supplier Oy or the case company. Moreover, an important role in this project played the biggest customer of the case company. It will be referred as the OEM. This is a big OEM that makes mining machines. The collaboration level between these two companies is high. In fact, Supplier Oy was established mostly to satisfy needs of the OEM. The case company was established in 2012 and since that time companies have developed strong relationships.

The case company specializes on manufacturing hose assemblies. A brief introduction to the technology is needed to have a deeper understanding of the case. Hydraulic hose assemblies are important components for machines in construction and mining industries. They enable transferring of extreme forces. Some machines require hundreds of hoses. The manufacturing process of hose assemblies has been developed a lot for the recent years. However, the main idea is still the same. Figure 37 shows components of hose assemblies.

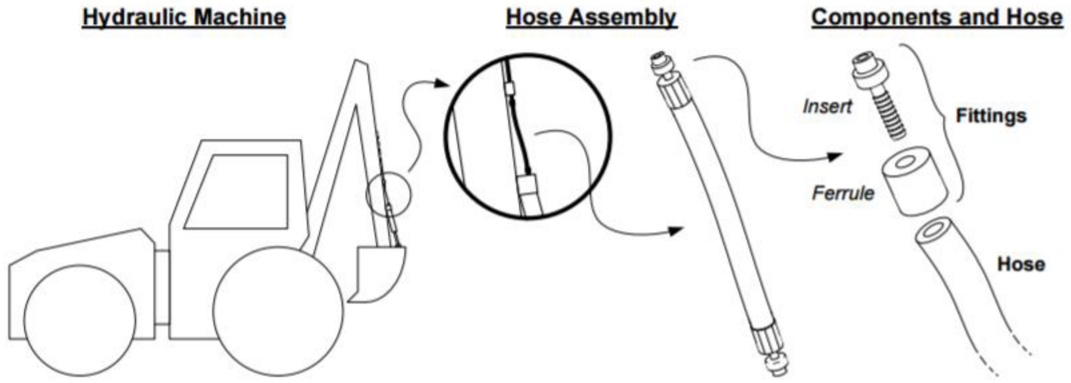

***Figure 37**. Hydraulic Hose Assemblies.*

Figure 37 shows that the structure of a hose assembly is rather simple. Apart a hose there inserts and ferrules which together make a fitting. The production process of hose assemblies is rather simple as well. First, a hose is cut according to the needed length. Then ferrules and inserts are attached to both ends of the hose. In the end, ferrules are squeezed using a press. Hence, they are strongly connected to the hose. Figure 38 illustrates the process.

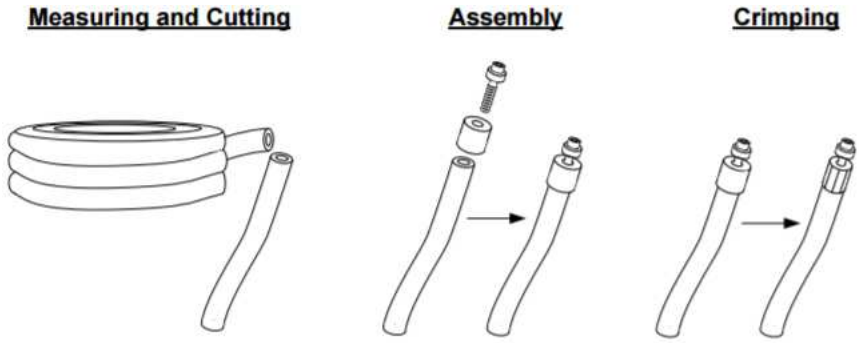

***Figure 38**. Hose assembling process.*

Figure 38 shows step-by-step production process. The first step is crucial and important for the case. The change in cutting technology gave an opportunity for this project. However, some important background of the case company and the hose assembly industry should be discussed.

In late 90s big OEMs started to change their ordering process for hose assemblies. Beforehand the way was established in a way that a hose assembly supplier would simply send thousands of standard hoses in batches to an OEM. Those hoses would be stored in the OEM. The system was built in a way that whenever some hoses were needed to be installed workers used to collect them themselves from the warehouse. However, the main problem was that OEMs had to have huge inventory because the amount of different hoses. Moreover, workers used to spend a lot of time for this procedure. Thus, OEMs in general decided to switch to a new way. The idea was that hoses were delivered in hose kits. Each kit contained all the hoses which were needed for a certain part of a machine. Figure 39 shows the difference between a hose batches and hose kits.

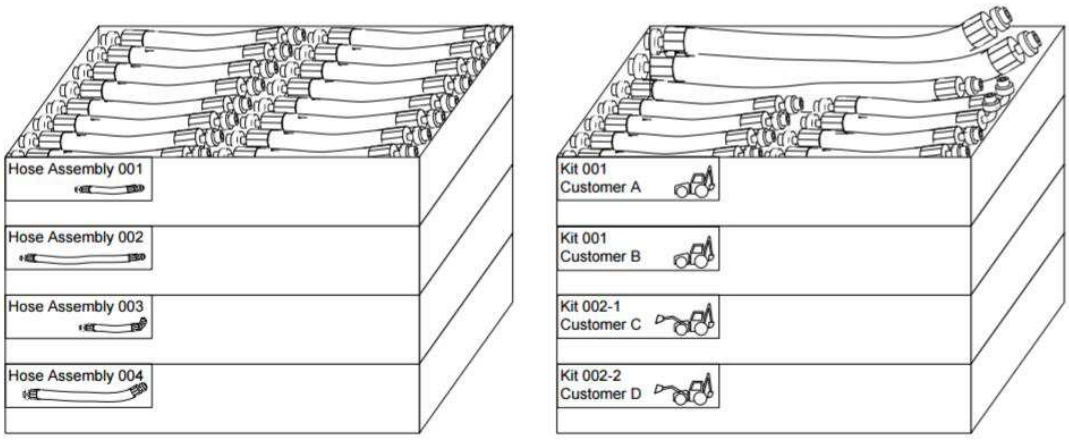

***Figure 39**. Batches of hose assemblies (left) and hose assembly kits (right).*

Figure 39 shows that each hose assembly batch has hundreds of identical hoses. However, a hose assembly kit consists of a variety of different hose assemblies.

Thus, when case company entered the market it focused on the production in kits because their main customer was the OEM. Supplier Oy bought new equipment to produce hose assemplies. It was different from what the previous supplier had. The new machines allowed Supplier Oy to produce hose assemblies directly in hose kits with high efficiency. The solution was perfect for the OEM and after some negotiations it switched from the old hose assembly supplier to the case company. It is important for the case to understand that for the past years Supplier Oy and the OEM have developed strong connections. They have managed to develop an extremely convenient right-on-time delivery process. Moreover, the case company is constantly developing its production process to achieve better outcomes. The OEM is the main customer of Supplier OY. Hence, the needs of this customers are crucial for the case company. Thus, the OEM has a lot of customer power and can push different projects to Supplier Oy. One of these projects was the pre-spiraled bundle solution.

To begin with, it is important to understand that each machine that OEM produces has hundreds of hoses. Some of them are simply connected to the machine. However, some hoses are bundled together and covered with a protective spiral. There are many different variations of bundles each has different shape, different amount of hoses. Figure below shows an idea of a bundle.

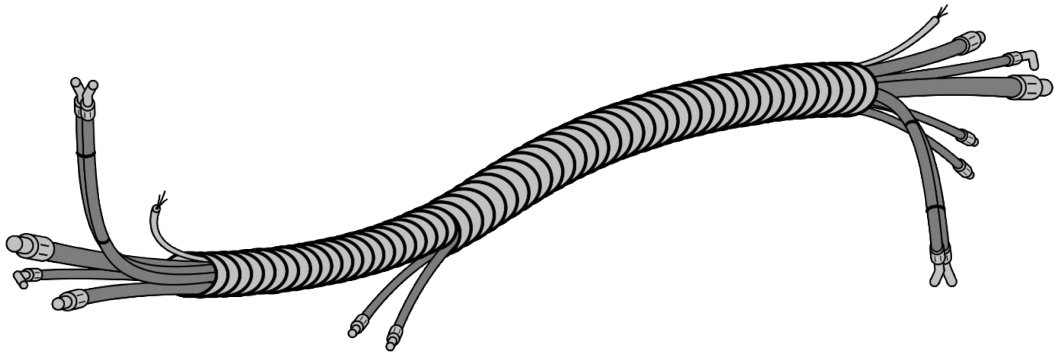

***Figure 40**. An example of a bundle.*

Figure 40 shows that at the first glance most of the hoses end in different places without any logic behind. However, the correct positioning of hose assemblies in the bundle is extremely important. Thus, for many years it was considered impossible to outsource bundles. Previously, bundles were made in-house by connecting hose one by one to a machine and then to other hoses making together a bundle. This process used to take enormous amount of time. Moreover, experienced employees were needed for this work.

However, switching from hose assembly batches to hose assembly kits significantly improved the process since one kit had all the hoses, which were needed for a certain bundle. Figure 41 shows that one kit contains all the needed hoses for a bundle.

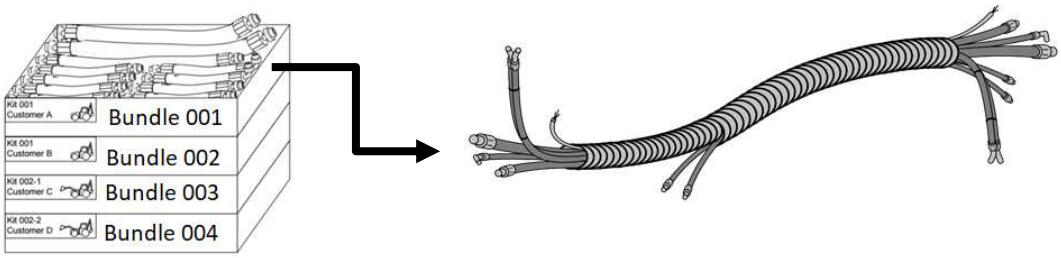

***Figure 41**. A bundle is made using hoses from a hose kit.*

Figure 41 shows that a hose kit was designed in a way that it had all the hose assemblies for one bundle. Thus, OEM's sourcing managers were pushing Supplier Oy to start developing a new pre-spiraled bundle solution. They though it was the next logical step in the hose assembly industry.

5.2 Wire harness and hose assembly bundles

The idea of a hose bundle or a hose harness came from automobile industry where wire harness is a common practice nowadays. Figure 41 shows an example of a wire harness.

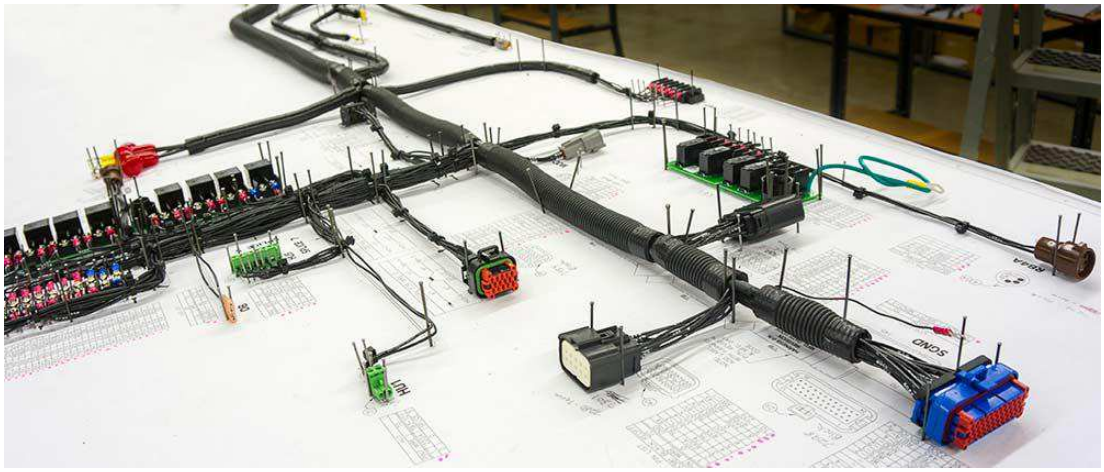

***Figure 41**. A wire harness.*

Figure 41 shows a wire harness assembly board that imitates a real vehicle. There are several benefits of wire harness. First, using one bundle instead of many separate wires helps to save space. Moreover, one of the main benefits for OEMs is that installation of one wire harness takes dramatically less time than installing cable assemblies one by one. For OEMs it helps to reduce production time for their machines in order to improve asset turnover.

In the mining machine business hose harness or, how they are called in the industry, hose bundles are frequently used as well. The idea of the pre-assembled hose bundle came from there. However, due to differences between cable assemblies and hose assemblies no one could bring this idea to life. The problem is that wire assemblies are much more

flexible. Furthermore, it has always been an understanding that positioning hose assemblies in a bundle is something extremely difficult. The believe was that hoses behave weirdly inside the bundle, and it is not possible to position the hoses properly without a machine. However, flexibility was still considered the main problem. Figure 42 shows how a single wire goes from point A to point B.

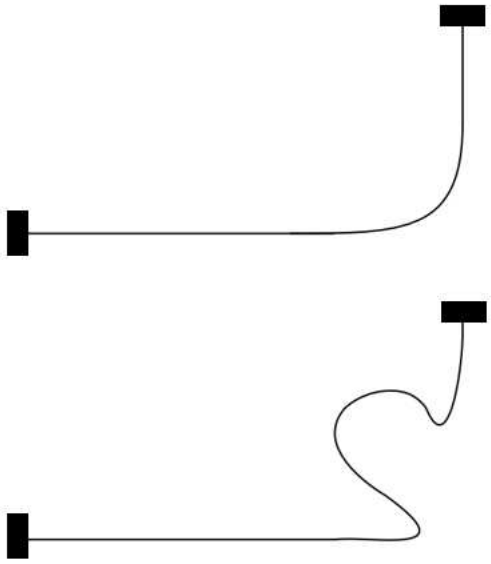

***Figure 42**. A wire assembly.*

Figure 42 shows on the top an example how a wire goes from point A to point B in ideal situation. On the other hand, figure on the bottom shows a possible case when the wire is way too long. The only problem with the second figure is esthetical, because the wire looks ugly. However, technically it is not an issue. Hence, it is evident, that it is easy to overcome length inaccuracy because wires are flexible enough to be positioned in any possible ways. On the other hand, it is not the case with hose assemblies. Figure 43 shows how a hose assembly goes from point A to point B.

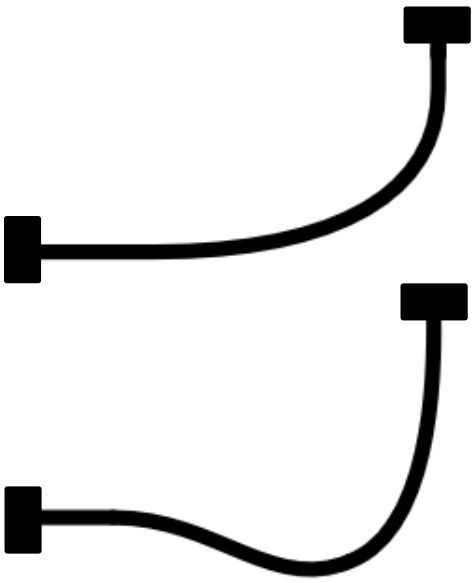

***Figure 43**. A hose assembly.*

Figure 43 shows that a hose cannot be turned 90 degrees that easily. Hence, the curves should be much bigger comparing to wire assemblies. The flexibility of hose assemblies is small Moreover, other difference from the wire assemblies is that the hose assemblies might be much thicker. The flexibility of thick hose assemblies is even smaller. Hence, all the turns should go smoothly. Moreover, an example on the bottom shows that it is much more difficult to "lose" extra length. Furthermore, even a rather small length inaccuracy impact on geometry of significant part of the hose assembly. Thus, the tolerance in length difference must be extremely small in the hose bundles. Sceptics of the prespiraled bundle solutions always has been saying that hoses are always 50-70mm different. Hence, it is not possible to standardize bundles and outsource them.

The solution to this problem came when the OEM switched from the old supplier to Supplier Oy. When the case company bought the new equipment the new type of cutting machines were purchased as well. Previously hoses were cut with manual cutting machine. With that kind of machine there was quite noticeable difference in length of hoses, especially with thicker ones. However, with the new hose cutting machines the difference in hose length decreased dramatically. Table below shows actual length of hose assemblies which are supposed to be 1400mm long.

Table 11. *Hose length.*

Hose number	New machine
1	1402
2	1398
3	1401
4	1402
5	1397
6	1403
7	1400
8	1404
9	1401
10	1402

Thus, Table 11 shows that with the new machine maximum deviation from desired length (1400) is 4 mm. The test was made using hoses with ½ diameter, which is considered rather small. For thicker hoses there were still quite big difference. However, it was much smaller than with previous technology. Previously it was cut manually and with that solution deviation even for ½ hoses was significant. The Supplier Oy had switched from manual cutting to the new machines several years ago.

Thus, when the cutting machines were purchased the OEM's sourcing managers started pushing the bundle project. However, the idea was to keep the development lean without major investments because still there were many doubts. Hence, as discussed, in Chapter 1 the outsourcing process of the first bundle took around a year and a half. Unfortunately, the details of the outsourcing process could not be reviled. After the first bundle was successfully outsourced and the efficient production process was designed OEM started ordering first bundles as a pre-spiraled hose bundles instead of hose kits. Figure 44 shows the lower frame bundle, which was outsourced first.

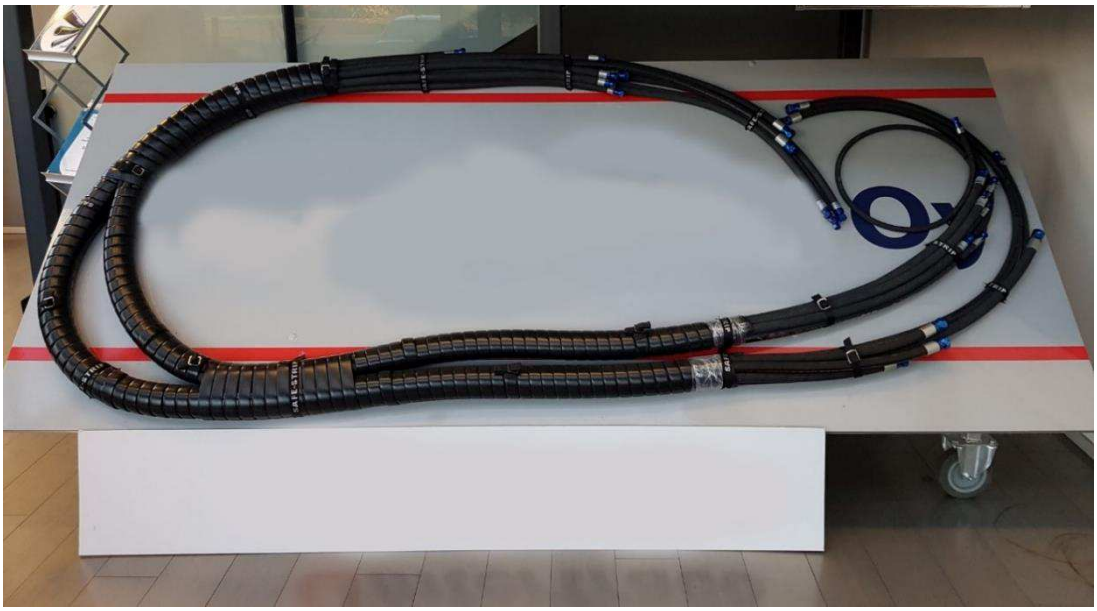

***Figure 44**. The first outsourced bundle.*

Figure 44 shows that the shape of the bundle is complicated. The most problematic part during the outsourcing process was to understand how to make this shape without a machine. Moreover, the project team from the case company realized that, even though they had support from the sourcing department, the production managers were still rather skeptical. Hence, this was another reason for the long outsourcing process. However, after the first bundle was outsourced the work with next types began to proceed much faster. During the next year there were outsourced three other bundle types. On the other hand, it was still rather small volume. The number of different bundles was too high and the time which was spent for ramping up process still too long. Hence, OEM's sourcing managers and the project team from the case company were thinking about other possibilities to utilize this new concept.

5.3 Boom bundle module

After first two bundles were outsourced successfully it became clear that the outsourcing of hose bundles is doable. However, some still had doubts regarding the outcomes of this project, because it needed a lot of resources and the outcomes were not that great. Thus, to make OEM managers interested the project team from the case company decided to take initiative and propose a next step for the project.

The second, third, and fourth bundles, which were outsourced, were for the same part of the machines. It was hydraulic boom bundles for three different boom types. Figure 45 shows a hydraulic bundle for the smallest boom.

Figure 45. *A hydraulic boom bundle.*

Figure 45 shows that this bundle is completely different from the lower frame bundle. However, all three hydraulic boom bundles are rather similar. Thus, when the project team was thinking about the next big step for the project they were thinking to continue outsourcing bundles for these booms because the hydraulic bundle was only one bundle out of three, which every boom had.

Thus, the project team decided to make a mock-up to show the possible direction of the project. It had been always a problem for the project team to get access to a real machine. Thus, to make this mock-up it was decided to simply copy shape of the bundle from photos available online. Figure 46 shows the image that gave first ideas to that full boom bundle concept.

***Figure 46**. A boom with three bundles.*

Figure 46 shows how the three bundles look hanging on a boom. Just based on this photo the mock-up was made. The mock-up was done by using waste hoses. Hence, the investments were really small. Figure 47 shows the first mock-up of the new concept. It was called a full boom bundle module.

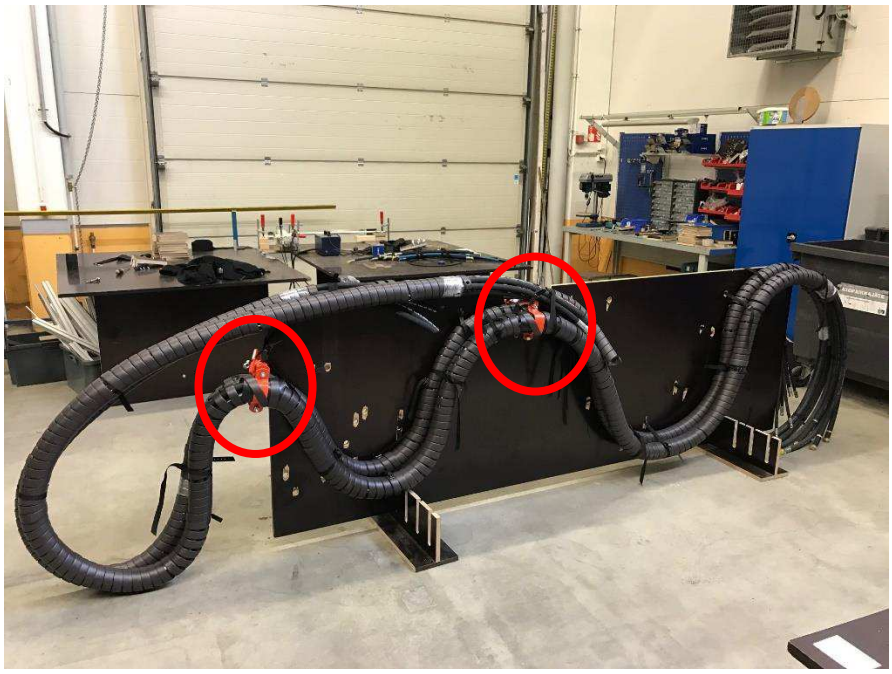

Figure 47. *First mock-up of the full boom bundle module.*

Figure 47 shows two drill bundles, on the other side of the board there is a boom hydraulic bundle, which was discussed above. These three bundles together make a full boom bundle module. The project team of the case company suggested that this should be the next step of the project.

The mock-up simply copies the shape of the bundle and approximate positions of the clamps which are highlighted in Figure 46 and 47. However, the mock-up played an important role for the communication process, since the OEM managers got the potential benefits. Moreover, they realized that with that solution the time savings that they could get were huge.

However, production managers had doubts in this project. They told that the drill bundles are two complicated and too difficult to outsource. Again, here the mock-up played an important role. The concept of a full boom bundle module was introduced to the after sales team. They liked the idea and immediately saw the potential of this project. They got excited about this. When the machine is being used the hoses fail quite often, and after some hoses has failed the whole bundle has to be changed. Thus, the idea of the after sales team was to deliver this full boom module solution worldwide to old machines as maintenance. Hence, people started seeing how huge could be benefits of this project. This module can save up to 80% of the maintenance time needed to change the hoses. The cost benefits are huge for the end customer.

The support from the after sales team was very important because the production managers were pressured more from inside the OEM. Hence, they were willing to allocate more time to help the project team from the case company.

After the both parties agreed to move on with this project. The project team form Supplier Oy visited the OEM and got all needed information regarding the new drill bundles. In a short time after that the first testing full boom module was built.

5.4 Surface problem

The first testing module was built in one week. It was with all the real hoses and it was ready to be tested in the production. Figure 48 shows the first testing module.

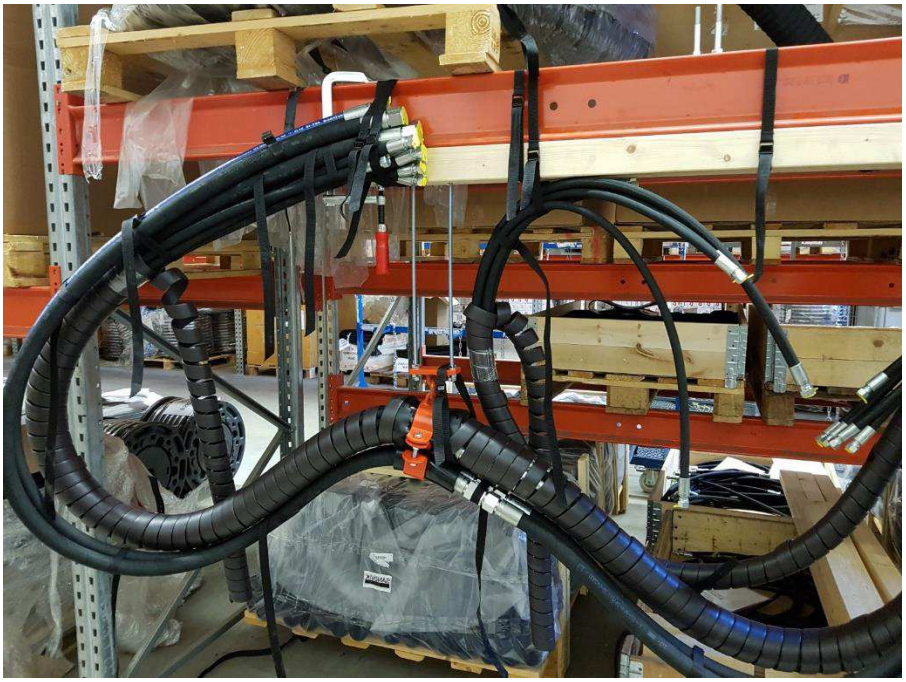

***Figure 48**. First full boom module.*

Figure 48 shows 3 bundles, which together make the full module. The small bundle on the background is the hydraulic boom bundle that had already been outsourced. However, two drill bundles had to be tested.

After it was tested the feedback was not pleasant. It had been agreed beforehand with production managers that the surface of the drill bundles would be parallel to “meet” hoses from the feeder, which were supposed to be parallel as well. However, it did not happen, and it was not possible to install the bundle. Figure 49 shows again the boom and explains why hoses from the feeder were not parallel.

***Figure 49**. A boom with three bundles.*

Figure 49 shows the place where the drill bundles are connected to the feeder hoses, it is highlighted with the blue circle. Hoses from the feeder go around a reel, highlighted with the yellow circle. A yellow line shows that hoses should be parallel. However, hoses are being tightened to make sure they stay in place when they go around the reel. Unfortunately, hoses behave in the different way when being pulled. Some hoses become longer than others. Thus, this creates a situation when hoses do not end parallel. Figure below shows such a case.

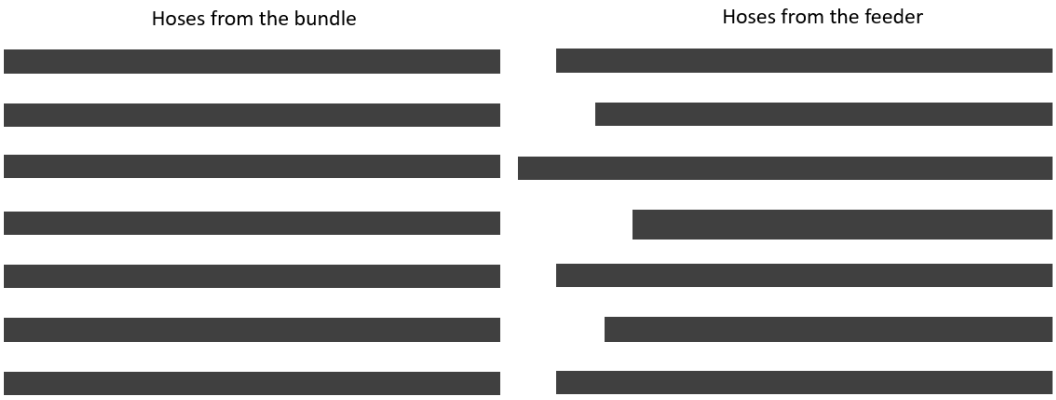

***Figure 50**. Hoses from the bundle and the feeder do not match.*

Figure 50 shows that hoses from the bundle do not match with hoses from the feeder. This problem did not allow to install the first testing bundle. Moreover, production managers considered that a huge problem that most likely could not be solved easily.

5.5 Fully functional mock-up

The project team did not have the access to the real boom in the production because the OEM was always in a rush and could not wastes production time. Hence, the project team decided to prepare their own solution that could solve the problem. They had suggested several ideas. However, it was too difficult to convince production managers to test any of them.

Thus, to persuade people from the OEM to test different solutions it was decided to make a mock-up of the boom. The idea behind it was that it would have allowed to demonstrate different solution. Hence, it would have been easier to communicate with decision makers. Figure 51 shows a fully functional mock-up of the boom on top and again a photo of the boom on the bottom.

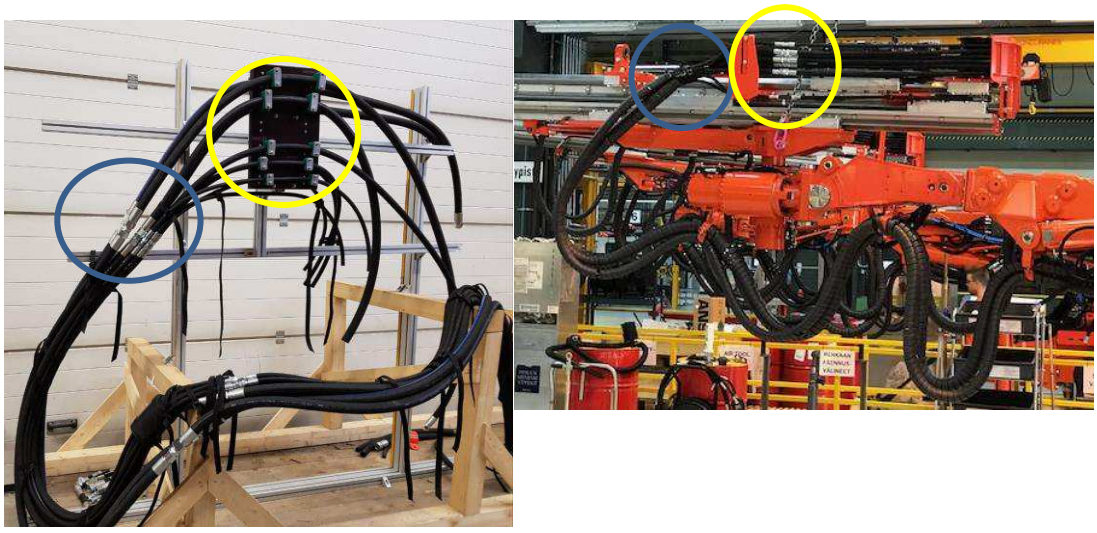

***Figure 51**. The fully functional mock-up and the real boom.*

Figure 51 compares the mock-up and the real boom. Blue circle shows the places where bundle meets hoses from the feeder, yellow circle shows the “comb”. The “comb” is a jig through which short hoses connect hoses from the feeder and hoses from the bundle. The yellow circle on the top figure shows this place in a mock- up. The functionality of the mock-up is the same as the reel. Hoses could be moved both directions, back and forward. Hence, this mock-up allows to play different scenarios and understand how hoses and bundle behave in every case.

With this mock-up different solutions and possible situation were tested, although they cannot be discussed in this thesis. However, the approach that the project team used can be discussed.

The fully functional mock-up was used to simulate different situations. Figure 52 shows scenarios that could happened with hoses from the feeder.

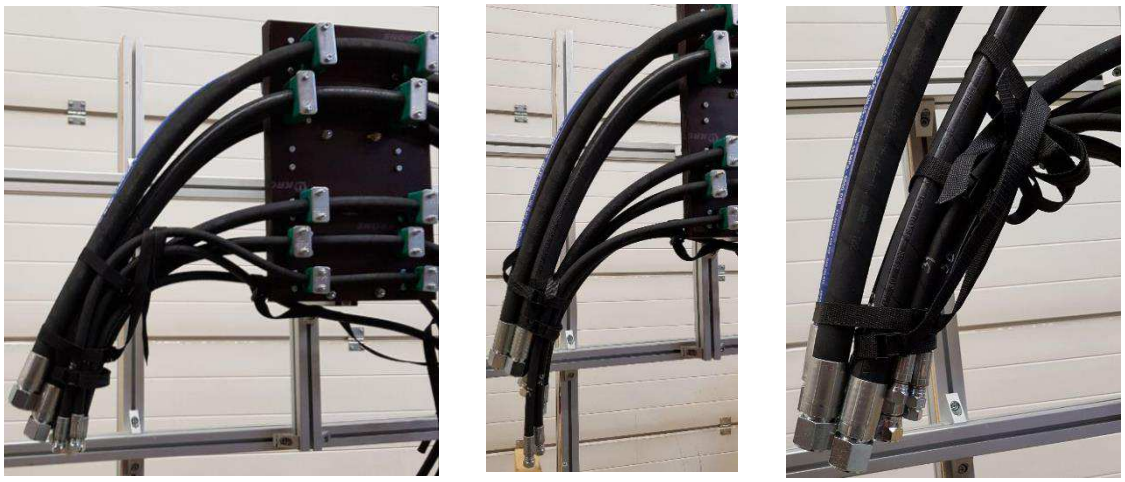

***Figure 52**. Fully functional mock-up of a boom.*

Figure 52 shows that, by moving hoses forward and backward, it is possible to simulate different scenarios. Different scenarios were tested using this mock-up. After that it was tested how to connect the bundle to each set up and, if the bundle does not fit, how can it be fixed. Figure 53 shows how the bundle is connected to the feeder hoses with different set ups and different solutions.

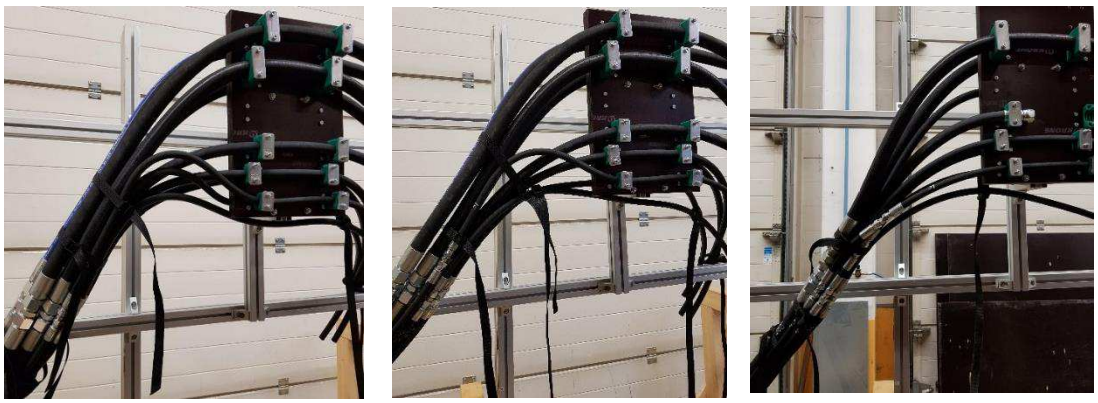

***Figure 53.** Fully functional mock-up.*

Figure 53 shows how bundle is connected to the hoses in different situations, showing different solution to the problem. In total the project team suggested three alternative solutions based on their tests. The OEM's managers agreed to test one solution, since it was easy to test. In a short time, the solution was tested and even though it required some extra work for the OEM's managers they agreed that it was the easiest solution.

6. DISCUSSION AND LESSONS LEARNED

6.1 Overview of the Problem and framework

Nowadays, companies try to get competitive advantage by different strategies (Lysons, 2006). According to Fawcett (2014), outsourcing is one of them. The most common benefit of outsourcing is that it frees manager's time and allows them to focus on core capabilities. However, there are many other benefits of outsourcing, although, companies often fail to achieve them (Lysons, 2006). In this thesis the taxonomy of outsourcing types was done. Each type was discussed regarding what benefits it provides. Moreover, it was analyzed that some types are more complicated than others. Furthermore, the importance of knowledge transferring process for outsourcing was discussed (Hawk et al., 2009). It was determined that the most risky and difficult type is total new assembly outsourcing, and it requires close collaboration between companies (Fawcett, 2014). The collaboration is necessary because only companies with good ties are able to efficiently transfer knowledge from one to another.

Knowledge transfer is a complex process which is crucial for a successful outsourcing (Hawk et al., 2009; Easterby-Smith et al., 2008). There are many antecedents of the process some have positive and some have negative impact (Wijk et al., 2008). The importance of the process for the total new assembly outsourcing is evident. Because of the nature of that type of outsourcing, a supplier basically learns from the customer to do a work that originally was done in-house. Hence, to transfer that work from the customer to a supplier the knowledge should be transferred. The nature of the knowledge impacts the process as well (Martikenaite, 2011). However, this thesis emphasizes the inter-organizational dynamics and on the company's characteristics, and how they affect the knowledge transferring and outsourcing.

It is suggested that for the greater outcomes of outsourcing the knowledge flow should go in both directions. Not only from a customer to a supplier, but vise-versa as well. However, there are some barriers which make it difficult. Figure 54 shows framework of the thesis.

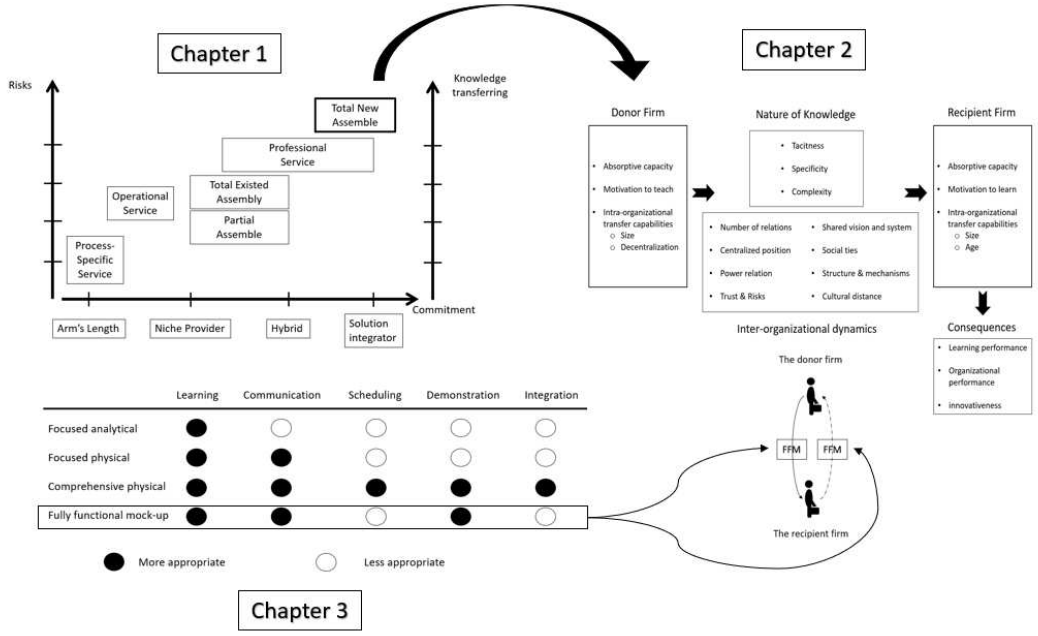

***Figure 54**. Thesis framework.*

Figure 54 shows that FFM can enhance knowledge transferring process between the donor and the recipient firm. Moreover, it helps the recipient firm to communicate with the donor firm by supporting its ideas. Hence, this thesis claims that, since the knowledge transfer essential for the outsourcing, FFM can improve outsourcing process. FFM is well suited for this process since it is cheap and fast to make. On the other side, it shows functionality at the same level as high-fidelity prototypes.

6.2 Reflection of the Case in Framework

As discussed in Section 6.1 total new assembly outsourcing is the most challenging type of outsourcing regarding the knowledge transfer. Most of the knowledge that is being transferred is implicit which makes the process more complicated (Hawk et al., 2009). The study was conducted in the case company based on the outsourcing project. Figure 55 shows that the outsourcing project from the case belongs to the total new assembly outsourcing type.

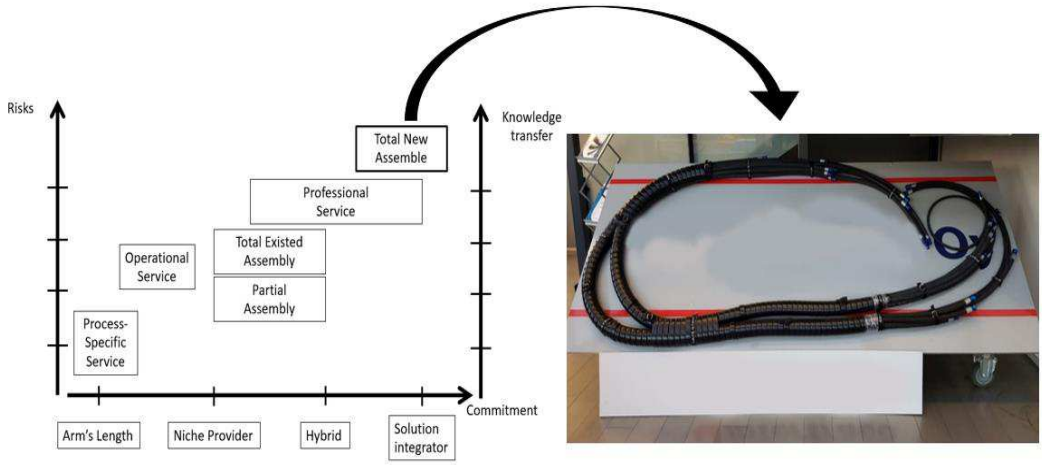

***Figure 55**. Bundle outsourcing as a total new assembly outsourcing.*

Figure 55 shows that the bundle project is an example of total new assembly outsourcing. It is evident because no one has ever outsourced this product before. Thus, the OEM had not only outsource the product, but also teach the case company how to make it. Hence, the OEM was the donor firm and the case company was the recipient firm in terms of knowledge transfer. Figure below represents the knowledge transfer between companies.

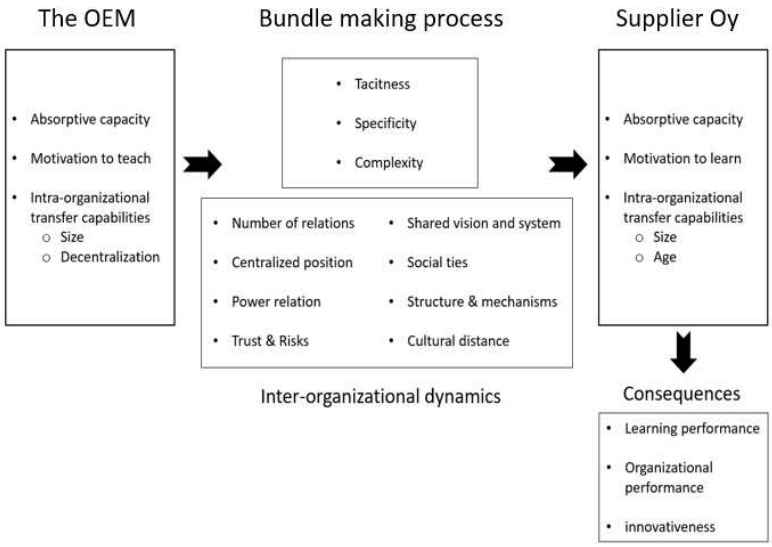

***Figure 56.** The knowledge transfer process between the OEM and the case company.*

Figure 56 shows that for the successful outsourcing process the knowledge had to be transferred from the OEM to Supplier Oy. During the process the case company faced some problems in the process. The OEM had to make changes in their production in order to allow the case company to start building the full boom bundle module. However, the OEM managers were not so easy to convince, and they had other ideas regarding that issue. Hence, to enhance their idea the project team from Supplier Oy decided to build a fully functional mock-up. Figure below shows benefits of the FFM that the project team wanted to use.

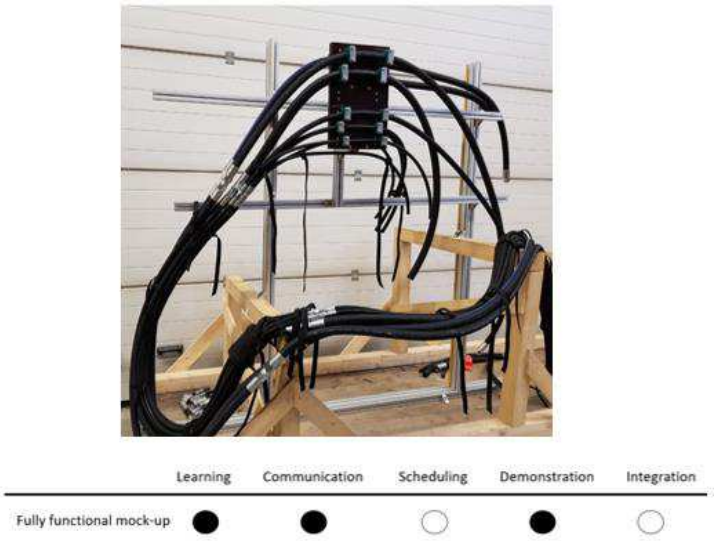

***Figure 57**. Fully functional mock-up and its purposes.*

Figure 57 shows that purposes of FFM such as communication and demonstration were important for the case company to demonstrate their ideas to the OEM. Hence, the FFM convinced the OEM's managers to test the idea that was generated in the case company.

6.3 Analysis of the Case Based on Framework

Analyzing the outsourcing process that the case represents, it is evident, that was new total assembly outsourcing, according to the taxonomy of this thesis, because the process has never been outsourced before that case. Thus, it was completely new process. Furthermore, it is evident, that the case company and the OEM have close relationship.

The biggest problem in this outsourcing process was the knowledge transfer. The OEM had all the knowledge regarding the bundle making process. However, the transferring process at first was quite difficult. Figure below highlights the most important antecedents which had impact on the process.

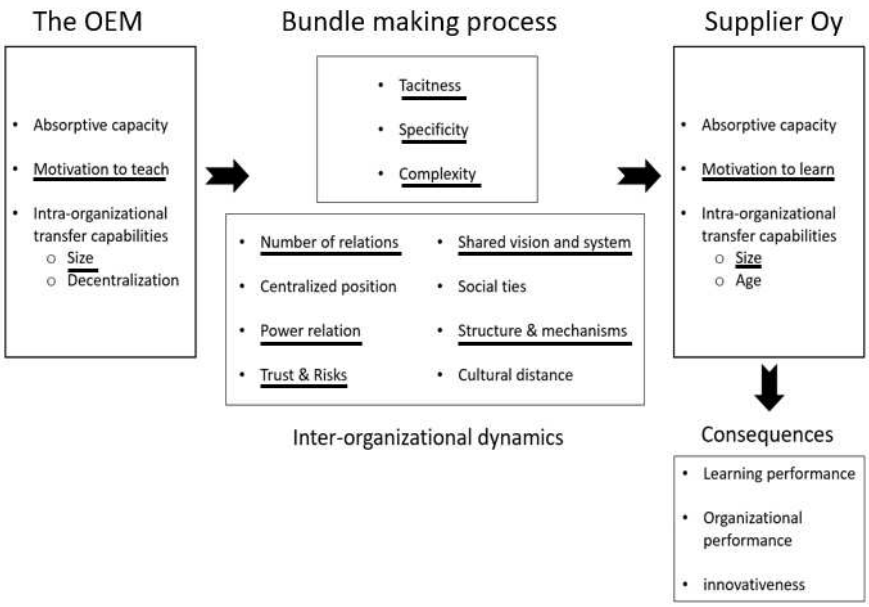

***Figure 58**. Antecedents of the knowledge transfer process.*

Figure 58 shows that nature of knowledge had impact the transferring process. Moreover, some characteristics of both companies and some characteristics of inter-organizational dynamics had positive or negative impact on the process.

First, the knowledge that was supposed to be transferred was highly specific, complex and bounded to OEM's employees. Most of the information regarding the bundle making process was not in explicit form, meaning that some crucial knowledge regarding the bundles were not documented and only employees of OEM knew it. Hence, to get it the case company's project team had to observe how employees work and ask questions to get desired information. This was a big problem, especially in the beginning. However, after several bundles had been outsourced both parties realized what information was important and what was not.

Second, the OEM has thousands of employees, whereas the case company is a rather small factory with around 30 employees. The small size of the case company impacted positively on the process, because the company was flexible and always tried to adjust to the OEM's schedule. However, decentralized position of the OEM had huge impact on the process. Even though initiative of this project came from the OEM's sourcing managers and the production was on board some other departments were not that convinced in the project and had something else prioritized. Hence, it had negative impact on the process.

Third, many characteristics of inter-organizational dynamics impacted the process in both positive and negative ways. High trust level was a crucial factor without it the project would not be even possible. The trust between companies eliminated risks of transferring important knowledge. For instance, the project team was given access to quite valuable

information. Shared vision was something that helped the project to begin because both companies are open to new innovations. In this collaboration power was on the side of OEM, it is difficult to estimate the impact that it had on the knowledge transfer process. However, it is evident that all the important decisions had to be done by the OEM. Because the OEM is a huge company it takes time to make decisions there.

Thus, in the beginning two departments from the side of the OEM were participating in the process and the project team from Supplier Oy. Figure below represents the idea.

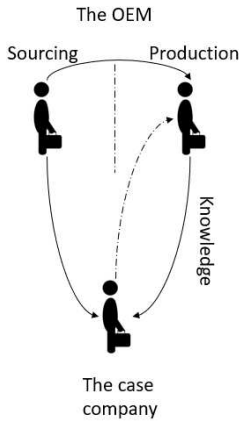

Figure 59. *Knowledge transferring process between the OEM and the case company.*

Figure 59 shows how the process was established. The sourcing people were pushing and enhancing the process, whereas the actual knowledge was transferred between production and the case company. The process was working like this for a long time. The process was developing rather slow and one of the problems was that production people did not have enough resources and motivations to enhance the process. However, after the case company motivated by sourcing managers suggested the full bundle module, discussed in 5.3, after sales department got interested in the project. After sales started pushing the process further and allocating more resources to the project. Figure 60 shows that after sales team added to the process.

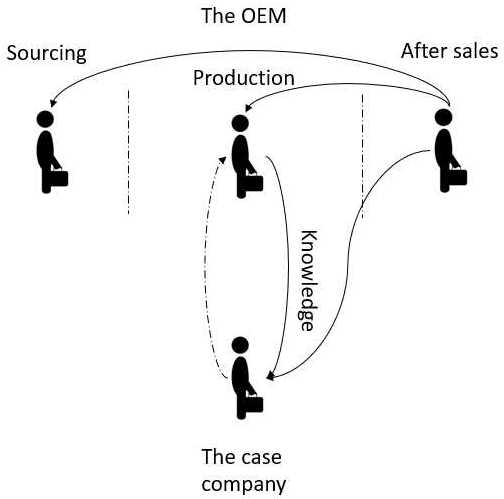

***Figure 60**. Knowledge transferring process between the OEM and the case company.*

Figure 60 shows that after sales team played important role in the project because being a part of the company it was easier for them to get the important information and pass it to the case company. Moreover, they were putting pressure on the production and helping them to allocate more resources.

However, after the first test of the full boom bundle module was not successful. The problem, discussed in Section 5.4 with the surface, seemed for the production people too difficult to solve. The project team suggested several possible solutions for the problem. However, they required some tests by the OEM and changes in their production. Figure below shows that the ideas seemed too complicated for the production. Moreover, it required some changes in the production process and production could not justify them for other departments.

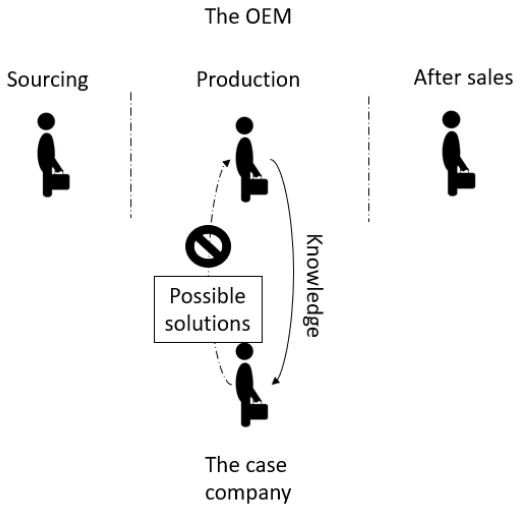

***Figure 61**. Knowledge transferring process between the OEM and the case company.*

Figure 61 shows the ideas from the case company were not used. Although, after sales were still interested in the project and wanted to try some alternative solutions. Moreover, sourcing people were supporting the project as well.

Thus, for the next several month ideas were coming from the after sales team and also from the case company. In order to demonstrate those ideas a fully-functional mock-up of a boom was made. The mock-up was discussed in 5.5. Several ideas were tested with that mock-up. The results were shown to the production and engineering senior managers. They liked one solution and gave a green light for it. Figure 62 shows that the FFM helped the case company to persuade production to test their idea.

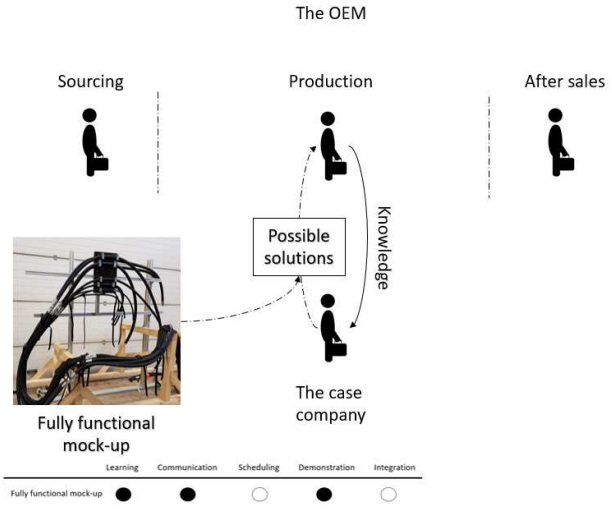

Figure 62. *Fully functional mock-up as a tool for knowledge management.*

Figure 62 shows that after production managers saw how the idea was implement using the fully functional mock-up they agreed to test in on one their machines.

6.4 Analysis of the results

Thus, based on the previous section, it is evident, that the fully functional mock-up helped the case company to overcome communication problems. Moreover, it served all the purposes which discussed in Chapter 4. Figure 63 shows purposes of FFM.

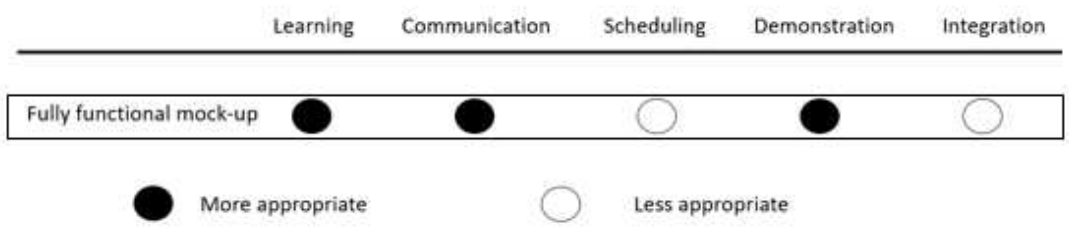

Figure 63. *Purposes of FFM.*

Based on the case outcomes it is possible to say that all three purposes were achieved. For instance, communication and demonstration goals were obviously met by persuading production managers to test the idea. Moreover, the learning purpose were used since the project team learnt many things using the mock-up and got much better understanding on the problem.

These findings are supported by the CEO of the case company:

> *"From our side this mock-up evidently pushed us in the correct direction. Because there were different solutions, but the reasoning was not strong enough to persuade managers from the OEM. Moreover, it is very important to show some evidence behind your statements."*

Moreover, the sourcing manager from the OEM who initiated the whole project agrees:

> *"This mock-up was very important. Because you did not have an opportunity to work with the real boom, and yet you had to somehow justify your ideas. Thus, copying the functionality of the boom even in a simple way allowed you to test different things. Moreover, having evidences helped you to persuade senior managers to understand and test your idea."*

They both agree that the mock-up played an important role in the project facilitating the decision-making process and persuading production managers to test the idea. Thus, the fully functional mock-up was successfully used in the knowledge transferring process. Thus, evaluating the impact of the FFM it is possible to say that it improved the outcomes of the knowledge transfer. Figure 11 shows the impact of the fully functional mock-up.

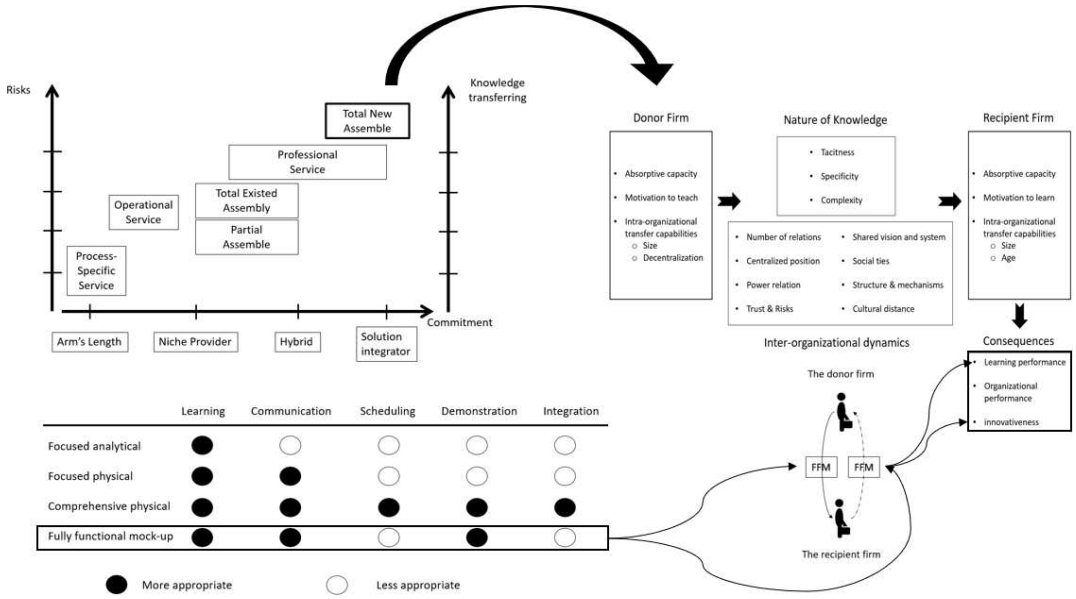

Figure 64. *Impact of the fully functional mock-up.*

Figure 64 shows that the mock-up improves learning performance. Moreover, it helps to make an innovative way to solve the problems of the surface.

7. CONCLUSION

In today's highly competitive market, companies are fighting to keep their competitive advantage and outperform competitors. One of the common strategies that helps companies to focus on their strategic capabilities is outsourcing. Outsourcing has become a common tool nowadays. However, there are still many problems regarding this process. Studies have shown that many possible benefits of outsourcing are not achieved by companies. One of the major problems with outsourcing process is knowledge transferring process. Due to complexity of the knowledge and the process companies often do not achieve desired results. The knowledge transfer usually goes in one direction from the client to the provider. This happens due to many reasons highlighted in the thesis.

This study was conducted to discover possible approaches that could improve knowledge transfer for the outsourcing process. The objective of this thesis was to introduce mock-up as a tool for knowledge transfer and discussed the impact that it has on the outcomes. To address the objective of this thesis, a theoretical review was conducted, and a framework was designed. To test this framework, a fully functional was built for the outsourcing project at the case company.

The important findings of this thesis were that fully functional mock-up can enhance communication process and improve outcomes of the knowledge transfer. The benefit of fully functional mock-up is that it is cheap and fast to make. On the other hand, it has benefits of expensive prototype and represents the functionality of the product. Thus, it is usable for communication and demonstration purposes. Hence, it can be used to support claims and ideas.

In the case company project the fully functional mock-up was built to push ideas from the recipient firm to the client. This rarely happens in the knowledge transferring process since the knowledge flow goes from the donor to the recipient firm. It is important that without the mock-up the idea would not have been approved by the donor firm. However, after some tests were made using the fully functional mock-up, the donor's managers agreed to test the idea. Thus, the mock-up served it purposes of demonstration and communication. Moreover, it resulted in innovation in bundle making process and allowed to make a huge step in the outsourcing process. Hence, it improved outcomes of knowledge transferred process. Figure 65 shows on the top what happened without the mock and how situation changed after tests with it in the bottom.

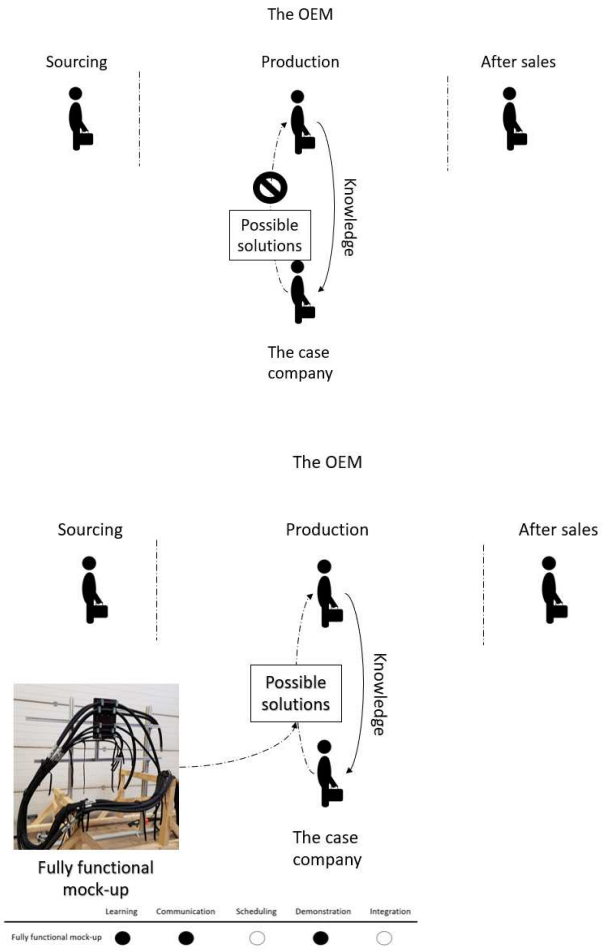

***Figure 65**. Impact of fully functional mock-up.*

Despite the interesting results achieved from the empirical study in this thesis, there are limitations. This study was implemented only in one project, there is no evidence to support its validity with other antecedents to the knowledge transfer. Moreover, the outcomes might be different for another type of the outsourcing process. Hopefully in future more researches are conducted in this area to test practical usage of fully functional mock-up in different environment and analyzing its impact on knowledge transfer which is conducted in different conditions.

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